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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Delayed in Publication

Publication Resumed

The presses of the McGraw-Hill printing plant are again running. The strike is not over, but a few of the same men, tired of the four weeks of bickering in union ranks, have returned to work. The Engineering News-Record has the honor of being the first paper put on the presses.

The issue, dated October 2nd, actually comes out October 30th. It is our expectation to make up all of the issues missed, but the pick-up at the start is likely to be slow.

When the presses stopped September 30th, the entire issue of October 2nd had been set up and electrotyped, ready for the press. Thus far, only pressmen have returned to work. We are, therefore, using the pages as prepared for the issue, with the exception of this page which is photoengraved directly from typewritten manuscript. We should like to have revised the News section, but, time forbidding, we are printing it as originally prepared. Some of the items are out of date, but most of them have value for record purposes.

Lack of time, too, forces us to omit entirely the Construction News Section, but the most important item—Bids Desired - are going out in an emergency bulletin, as they have in the past three weeks.

Next week we hope to get out an issue more nearly normal. We expect at least that it will be up to the minute in both construction and general news.

A Word of Thanks

Upon resumption of publication, we desire to express formally our heartfelt appreciation of the patience of our readers during the suspension. Two classes in particular have been seriously inconvenienced-- engineers who have had contracts to let, and contractors who are seeking work. One and all, they have tolerated the inconvenience and the financial loss without complaint. More than that, they have encouraged us to stand firm in our resistance to radicalism.

For all of which we are most sincerely grateful.

Big Contractors in Road Work

In the spring C. S. Hill, associate editor of Engineering News-Record (see issue of June 12, page 1156) reported the views of large contracting organizations on taking highway contracts. The attitude was unfavorable. Therefore, it is all the more interesting to note that a goodly number of large contractors, hitherto engaged in other lines of work, have taken road contracts. The comment is all the more pertinent because of the awarding late last month of an $826,000 contract, in Ohio, to the Bates & Rogers Construction Co., the well known Chicago firm. Obviously, the scarcity of other work accounts to some extent for the entry of those large organizations into road work. Undoubtedly, too, they realized the coming volume of highway construction, and have considered it worth while "to try it out." The results of their experience will be interesting. Will they find that their objections have been removed? Will they find the relations so satisfactory that they will be permanent additions to the roll of highway builders? By the coming of winter we should know. The answer is one of great importance to the highway field.

Highway Work Limitations

What the attitude of large contracting organizations will be toward highway contracts may determine the volume of work to be done in the next few years. Indications are that funds will not be the limiting factor. The supply of stone and gravel, however, may set a limit on the work. In some Eastern states there is great difficulty in getting deliveries. The situation is likely to be more acute when other forms of construction get under way. Another critical factor is the future supply of competent engineers. A scarcity seems to be indicated. These are all serious problems, none of them easy of solution. Probably the least difficulty of all will be the supply of contractors, provided the work is made attractive by the same fair dealing that large organizations have been accustomed to on private work. The material situation can be investigated in each state and encouragement offered by surveys that will locate quarry and gravel-bank sites. The most difficult of the problems will be to secure men. The colleges cannot rush them through in a single year. Young men can fill only the subordinate jobs. The scarcity, therefore, will lie in men of experience. Undoubtedly, the salary scale will go up with the demand and some relief will be found in the transfer of engineers, though without highway experience, from less lucrative employment. The whole situation is one that invites the interchange of views at engineering society meetings during the coming fall.

State Highway Department Standards

THE objections alleged by contracting organizations against taking up highway work were undoubtedly based to a large extent on the experiences of these organizations with the work of municipalities and counties. That has often been notoriously unsatisfactory. The reasons are various and need not be detailed here. It is pertinent to remark, however, that much better conditions obtain in work let by state highway departments. In general, these bodies are well organized, are sufficiently manned and are conducted on high standards, with little political interference. Undoubtedly the true situation was not realized by large contracting organizations, and for that reason alone, a considerable change in attitude is to be expected on the part of those who formerly objected but who nevertheless took highway contracts this year.

Breaking Down Distance Barriers

THE new Pacific fleet recently arrived at San Francisco, which is to be its future headquarters. The fact that we are to maintain a representative fleet in the Pacific has a bearing on Western industrial development; it cannot but promote a feeling of security and greater confidence on the part of capital. More than this, however, significance attaches to the short space of time in which this armada was transferred from Atlantic to Pacific waters. The result is more than a historical landmark, because it calls for a readjustment of our habit of thought and our attitude toward industrial prospects in and political relations between widely separated territories. During the war with Spain in 1898, the battleship Oregon made history in a record breaking dash from San Francisco to Key West, but that trip required more than nine weeks. In contrast with this, the entire Pacific fleet passed through the Panama Canal between dawn and sundown, while the entire trip can be made from New York to San Francisco under three weeks. To carry the thought further, there is in the rapid development of aërial transport, probability of still closer contact—a further reduction of the old geographical barriers. As the world, in effect, becomes smaller, the situation in each political or commercial unit has an increasing influence on the situation in every other unit. Barriers are disappearing rapidly. To keep abreast of modern advances commercially it is becoming more and more necessary to think in terms of broader fields of operation.

Airplane Service Progress

SOME weeks ago we commented upon the progress that was made in airplane development during the war and the probability of rapid growth of the new transport agency in civil life. Except for our air-mail service between New York and Washington, we have had to point to achievements abroad as evidence of progress. We are not, however, to be without results here. Last week, for example, after a successful flight from Milwaukee to New York, the airplane designed by Alfred W Lawson carried 14 persons from New York to Washington, the time being four hours and fifteen minutes. A passenger airplane service between New York and Atlantic City has been carried on for some months, while the New York-Cleveland mail service can now be counted with the Washington service as an established success. In fact, the trip made in this service, Sept. 25, deserves special record. The 430 miles (changing planes at Bellefonte, Penn., and carrying 335 lb. of mail) were flown in 179 min. or at the rate of 144 miles per hour On the very same day a Martin bomber made a non-stop flight between Cleveland and New York with four passengers, guiding itself entirely by compass. As this sort of evidence of the stability and reliability of airplanes increases in volume, the confidence of the public in this mode of travel will increase, as will the faith of those who are seeking an outlet for investment. An overnight popularity of airplane travel is not to be looked for, but the development is nevertheless definite.

Sand for Winter Use

IN MOST parts of the United States it is extremely difficult to get sand in the winter months. Particularly where such sand comes from underwater or in water-bearing deposits, deliveries stop as soon as winter sets in. Contractors who contemplate or expect concreting work this winter should bear this in mind and should get into storage as soon as possible as much sand as they will need until spring. Winter concreting is a common thing now that we have learned to do it safely, and there are indications that there will be much of it next season. By being prepared, much worry and delay will be avoided.

Letting Next Year's Road Contracts This Year

OF ALL public and semi-public construction, none resumed operations more quickly or on a larger scale than highway work. Yet, in spite of this seeming good record, no one who has been in contact with highway work can help observing that there has been a loss, due to delays in starting many of the larger projects, of not less than two and possibly three months of the actual construction season. With the regrettable example before us, there should be no repetition of these conditions next year.

At the beginning of the year there were large sums immediately available for construction purposes, but public officials, with many others controlling private entreprises, hesitated to award contracts. In spite of the prediction of many business men that prices would not go lower, many public officials deemed it wiser to delay action. As a matter of fact, contracts awarded later have averaged from 10% to 15% higher than those let in the early summer.

Contractors looking for prospective work had no means of knowing what the construction program would be. Many of the highway offerings evidently would be of such extent as to require contractors with large organizations and large plants. But while matters were held in abeyance contractors were not in a position to arrange for the needed plant. Consequently, equipment orders piled up as the season progressed, and the builders were not able to make deliveries. Likewise, there was no opportunity for contractors to accumulate materials, and now the car shortage theratens further serious curtailment of the construction program.

The prospective highway program for next year is even larger than that of a year ago. If the work is to be handled to the best advantage, it is necessary that

more time be given contractors to organize. This done, the public will secure lower prices and quicker work.

If such conditions are to be brought about, highway officials should ask for bids in November or December of this year on as great an amount of work as can be prepared, provided, of course, the funds are available, which, fortunately, is the case in many states. Contractors will then know what to provide for next year, will lay in stocks of materials and place orders at once for machinery for delivery before the season opens. The costly delays experienced this year would be eliminated, to a great extent.

Railway Bridge Floors

LONG paneling as used in the Coal Valley bridge is in harmony with progressive views in modern railroad-bridge design. The reason for using 43-ft. panels, clearly stated in our article, is the same that controls or should control other cases where long panels may come into question; namely, that the truss is improved by simplification. This means reduction of secondaries and reduction of field connections, two important advantages. They may be gained at the cost of some added metal, but there is at least one auxiliary advantage that helps to counterbalance the loss. The mere increase in weight of the floor is an advantage, by no means negligible, as it produces a solidity very favorable to the suppression of live-load impacts. Since experience has shown plate girders to possess a higher degree of reliability and reserve of strength than is credited to trusses, ultimate economy, doubtless, is on the side of long panels as compared with short panels, even though weight comparison of design may point the other way. On this account it is not impossible, we think, that the same reasons which argue for a moderate increase in panel lengths would also hold for the use of much longer panels, which would involve going to bridge proportions of quite unusual kind. Useful results in this direction, however, are more likely to be reached by progressive development than by a single radical step away from recognized practice.

Important Records of Engineering—Data on Repairs

THERE is a special art in the work of repair and rebuilding of engineering structures. Schools do not teach methods of doing such work. Nor do texts give any help. The work depends on original resource, and brings into play the engineer's most highly developed skill. The art of repair must be learned through practice, and through study of the work of others. Because of this, technical accounts of such work have a place of peculiar importance in our engineering literature.

Yet the truth of the matter is that such accounts are rare indeed—almost as rare, perhaps, as records of operating experience. It would seem that technical writers prefer to deal with descriptions of new construction. Perhaps the glamour of new design conception, and the finished impression of a structure just built, make mere patching and revamping seem trivial. Whatever the cause, the result is beyond doubt: Far too rarely are adequate accounts of reconstruction operations made public.

A double loss is involved, for, besides carrying the teaching and inspiration of skilfully exercised engineering resource, the descriptions of repair have a separate and still more important element of value. They embody service records and thereby supply data upon which engineering progress is more or less directly dependent.

This is because repair tells of existing faults of engineering method. Every replacement or strengthening means a prior failure. It is true that the failure may not have been premature but may have occurred in the fullness of time; it may have been a justifiable or natural failure, or the opposite, and the mere fact that a failure occurred is not discreditable to the original design and construction. Nevertheless, the facts of the failure, when taken in conjunction with the time of service, throw light on the merits of the engineering methods originally applied. They are the results of the service test.

Let it be recalled that the larger part of engineering, as it has been developed through generations and centuries, rests on empirical foundations. Nearly every single step of advance was made by virtue of the knowledge gained by the service of prior construction. A design is, even today, at least a prediction, a promise of efficient service; the facts themselves can be found only in the subsequent service record. Is there, then, much exaggeration if we assert that one service record is worth a dozen designs? Regarded from this standpoint, there need be no question as to the value of accounts of repair work; for such work, when based on thorough analysis of the defective conditions found, is a service record of truest kind.

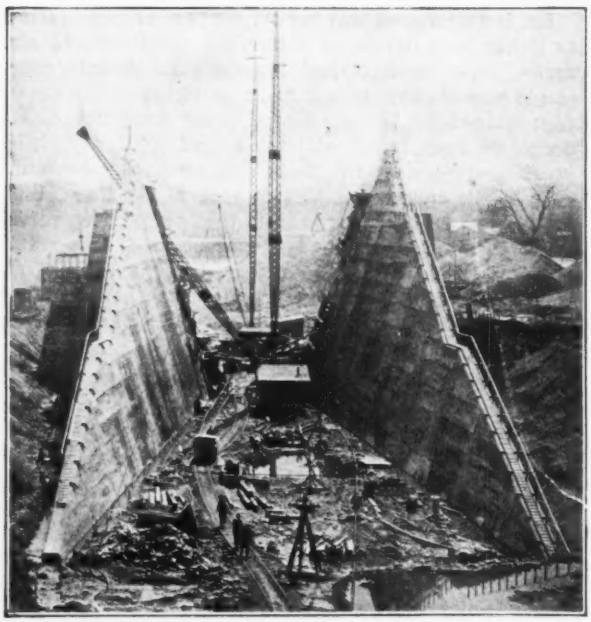
At least three elements are included in the scope of properly executed repair work. There must, first, be a diagnosis of the existing conditions which make the repair necessary. Following this, the various reconstruction procedures must be studied and the best ones selected. Finally, there is the execution of the work itself. Instructional value resides in all of these, but particular interest attaches to the first, the diagnosis. Not only does it demand keen observation and highly skilled judgment concerning both tangible and intangible facts, but it alone supplies the service data just referred to. It should be obvious, then, that, more than all other parts of a repair undertaking, the diagnosis is worth the engineer's careful attention when he sets down a record of the work. The ultimate analysis of the entire job centers in clear and thorough study of the conditions precedent; and so also the excellence or lack of excellence of the report of these findings will determine whether or not the record is to be a lasting contribution to the world's engineering progress.

Recently the pages of *Engineering News-Record*, within the space of three weeks, contained accounts of two remarkable repair operations. The two articles, one describing the restoration of a large swing bridge, the other a well studied repair of a fixed structure, constitute an exception to our statement that such articles are rare; but this very exception emphasizes, by contrast, the dearth of such records in current engineering literature. This dearth, we feel certain, is not chargeable to the scarcity of engineering repair work in itself, nor to the lack of thorough analysis of the conditions which call for such work. Were the importance of such records fully appreciated by engineers, many other accounts of repair work having high instructional value would be published, and our stock of engineering data would be significantly increased.

Concreting Procedure on Miami Flood-Control Dams

Equipment and Methods Standardized for Five Separate Jobs—Standard Product Secured by Test Control of Varying Aggregates

STANDARDIZED procedure, based on tests of materials and product, maintained concreting operations at consistently high speed, uninterrupted by winter weather, on the outlets for the retarding-basin dams of the Miami Valley flood-control works. For all principal operations identical equipment and methods were employed in procuring and preparing concrete materials and in mixing and distributing concrete. For placing concrete, substantially identical equipment was



LOCKINGTON RETAINING WALLS COMPLETED TO HIGHEST POINT 84 FEET ABOVE BASE

employed for each of the two types of outlet structure.

About 173,000 cu.yd. of concrete is required for the five outlet structures. This is distributed as follows: Lockington, 38,000; Taylorsville, 47,000; Englewood, 38,000; Huffman, 40,000 and Germantown, 20,000. At Englewood and Germantown the outlets consist of twin conduits through the dam embankments for normal river and ordinary flood discharge, and of separate safety spillways around the ends of the dam for extraordinary floods. At the three other locations, the spillways and conduits are combined in single structures. These consist each of a retaining-wall channel through the dam embankment; across this channel is a weir, the crest of which forms the safety spillway and through the base of which conduits provide for the normal discharge.

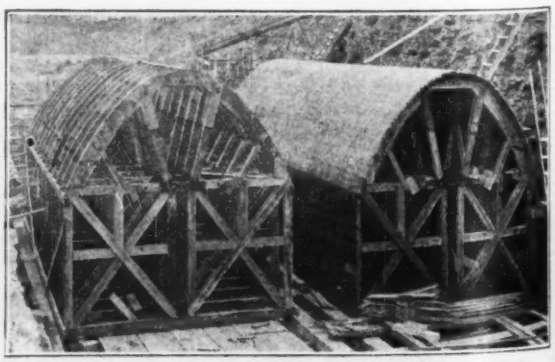
A feature of the construction of both types of outlet is that they are first built to provide a larger waterway than is finally required and will, therefore, be constricted by additional construction to be performed later. The purpose of this was to provide as large an escape for floods as was possible during construction, when the embankment work was not ready to impound water. In the case of the twin conduits, the sections were built nearly twice as high as they will be finally. These sections will be reduced by filling the bottom halves with gravel and constructing concrete cross-floors. In the retaining-wall outlets the cross-dams are not built at first; thus unrestricted open channels are left for flood discharge.

Completion of the outlets as considered at this time does not mean placing the total volumes of concrete enumerated above. The records of concreting to be given relate to only four dams. At Taylorsville embankment construction was not required to await the outlet work and other conditions placed the concreting at a later period in the construction schedule. The equipment and methods there will, however, be exactly like those at other outlets of the same type. The four outlets on which construction is substantially completed involve 90,000 cu.yd. of concrete.

Dam construction operations were: (1) Concreting outlet structures, and (2) hydraulicking embankment. The major task was embankment construction. Other operations, therefore, had to clear the way as rapidly as possible for hydraulicking. At all the dams except Taylorsville the locations of the outlets and the job topography were such that the beginning of embankment had to await substantial completion of the outlets. Finally, since the dams were units of a single system of flood protection, their construction had to be so scheduled that completion would be simultaneous.

These conditions determined (1) that outlet construction must go ahead at the same time on at least four of the dams; (2) that it must precede embankment construction; and (3) that it must proceed with speed. At all dams local deposits of gravel were used as aggregate.

Structures from 20,000 to 47,000 cu.yd. in volume, including retaining walls 80 ft. high and twin conduits 1000 ft. long, set in deep pits to be excavated just ahead of the concreting operations, called for separate and highly concentrated assemblages of equipment. To simplify the problems of assembling, interchanging, maintaining and operating this equipment, standardization was considered essential. Six main operations were involved in this task: (1) Mining and delivering



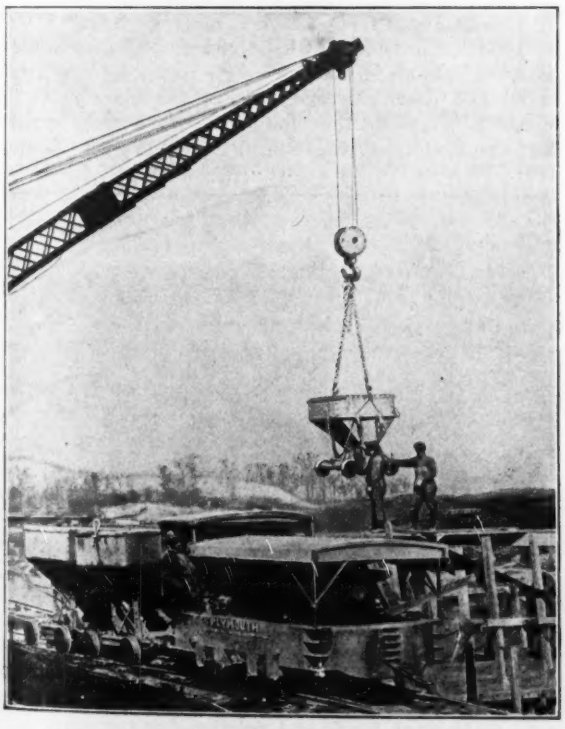
ARCH FORMS IN PLACE FOR TWIN CONDUITS AT ENGLEWOOD

gravel; (2) preparing aggregates; (3) proportioning and mixing concrete; (4) transporting concrete, (5) distributing concrete; (6) excavating rock emplacements.

The following plant was adopted for each outlet operation: At the pit a dragline excavator loading cars; dump-car and dinky-locomotive haulage to the gravel plant; a gravel-washing and screening and a materials-storage and concrete-mixing plant identical for the five dams; gasoline-operated industrial railways for delivering concrete; either derrick or chuting outfits for placing concrete; and drilling, blasting and dragline excavators for preparing emplacements. The two types of outlet structure, but more directly the outlet locations and the job topography, necessitated different concrete-placing outfits, but otherwise there was for all dams close similarity in the procedure and equipment for each process, and for most processes absolute identity of equipment.

Aggregates for concrete were obtained by washing and screening gravel from local deposits. At each dam site the deposit was carefully explored and analyzed for quality and granulometric composition. The exploration was conducted by digging test pits to groundwater level and using sand pumps for deeper exploration. The samples obtained were analyzed for density of component stone, gradation in size of grains, proportion of voids, and content of silt. Using the sand and pebbles of the samples, 2-in. cubes of 1:3 mortar and 6 x 6-in. cylinders of virtually 1:2:4 concrete were molded and crushed, with results that showed the gravel deposits at all dams to be entirely suitable for concrete aggregates.

Granulometric variation was the chief problem disclosed by the analyses of the gravel deposits. At Germantown and Huffman the deposits were uniform and the material was naturally well graded. At Lockington the natural material had an excess of small sizes, but lacked in very fine sizes. At Englewood the deposit was streaky.



LOCOMOTIVE CRANE LIFTS CONCRETE CAR OVER CHUTE HOPPER

Standard washing and screening provided for two sizes of coarse aggregates, 3 to 1½ in. and 1½ to ⅜ in.,

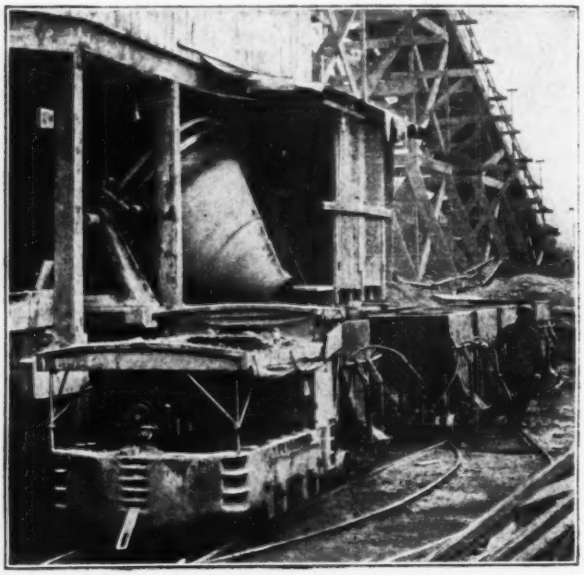
BELT CONVEYOR DELIVERS PIT GRAVEL TO SCREENS AND WASHER

delivered into separate bin compartments, and of sand delivered into a third compartment between the other two. The purpose of separating the coarse aggregate into two sizes was to overcome pit variations in the aggregate content of the concrete. Where the gravel in the pit ran first coarse and then finer, these variations, it was reasoned, would appear in the gravel in the bin if all sizes were screened into one bin, and the concrete would be now heavy in coarse aggregate and again heavy in fine aggregate. By screening into two sizes and drawing equally from both bins for each batch, this was avoided, and the operation required no greater screen length or bin capacity.

Modifications in standard plant and processes were principally in connection with handling the sand, and have been described in *Engineering News-Record* of Feb. 27 and Mar. 6, 1919, pp. 445 and 492. In general, the sand hoppers at all the plants retained an excess of water in the sand. These hoppers are vertical inverted cones into which the washed sand is discharged from the sand screen. Most of the wash water in the sand overflows through a spout which is notched into the upper edge of the cone, while the sand is periodically discharged to the bin through a counterweighted valve in the bottom of the cone. In operation too much of the wash water remained in the cone and was discharged into the sand bin. At each plant, therefore, a supplementary device had to be installed to take the cone discharge, drain out the excess water and transfer the sand to the bin.

At Lockington dam the pit gravel ran small, about 90% being under 1½-in. size, and contained an excess of grapeseed grains and a scarcity of finer grains. The standard ⅜-, 1½- and ⅜ in. screens being used, the ⅜-in. screen, having most of the work, became clogged, and much of the material finer than ⅜ in. was carried over

into the stone bins. A set of auxiliary sand screens had to be installed underneath the ¾-in. screen, and in addition flow through this screen was retarded by the riveting on of inside baffle plates, and additional washing water was introduced to keep the openings flushed. To make up the deficiency of fine sand, the wash water



MIXERS DISCHARGE DIRECTLY INTO INDUSTRIAL RAILWAY CARS

which ordinarily carried away much of this material was passed through settling tanks from which the fine sand was salvaged and placed in the sand bin.

Except in respect to the modifications noted, the operations of preparing aggregate were alike at each dam. Pit gravel excavated by dragline excavators was loaded into 12-yd. dump cars which were hauled by locomotives to the gravel plants and there dumped into hoppers feeding belt conveyors to the screens on the top of the stock bins. Very large stones were picked out by hand at the bottom of the conveyors, but otherwise every process from pits to stock bins was mechanical.

The problem of concrete proportioning and mixing involved these principal factors: (1) Preparing four qualities of mixture according to the place of concrete in the outlet structure; (2) maintaining each quality of mixture at approximately the same strength standard; (3) keeping each mixture workable to the highest degree practicable without overburdening the concrete with water. As in preparing aggregates, the solution was to adopt a basic procedure determined by tests and to modify this procedure in detail when necessary.

For each of the four qualities of concrete, the cement content was constant, being 5, 6, 7 or 8 bags per batch of a 1-cu.yd. mixer, but the aggregate proportions varied with the material at the different pits. As examples of this variation, the exact proportions at two dams were:

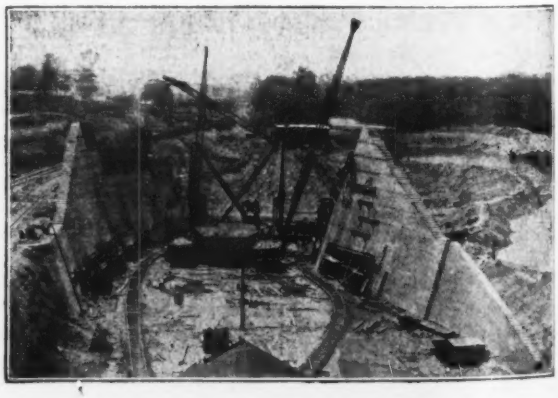
Bags Cement	Lockington	Germantown
5	1 :2.7 :6.6	1 :2.66 :5.96
6	1 :2.25 :5.5	1 :2.22 :4.97
7	1 :1.93 :4.7	1 :1.90 :4.26
8	1 :1.5 :2.5	1 :1.66 :3.32

The two intermediate mixtures were used for the bulk of the work; the leanest mixture for portions of the footing and backing concrete, and the richest mixture for lining the conduits.

As a mixing problem, therefore, concrete production was not a task of adhering to fixed measures, but, as previously stated, a task of producing by proper manipulation of materials and mixer action four workable mixtures of standard qualities. Based on analyses of the aggregates available at each dam and on workability tests of mixtures of these aggregates, basic volumes of aggregates per batch were determined and the measuring chutes were set to these volumes. These chutes were, however, adjustable so that quick change in aggregate proportions could be made when occasion demanded a change. At Lockington, for example, the basic volumes determined were, for each batch, 13½ cu.ft. of sand under ¼ in., 11 cu.ft. of gravel between ¼ and ¾ in., and 22 cu.ft. of gravel larger than ¾ in. At Germantown the quantity of sand was set at 12½ cu.ft., but the coarse aggregate varied from 14 cu. ft. small and 11 cu.ft. large for arches, to 16 cu.ft. small and 12 cu.ft. large for floors and walls. These variations at two locations exemplify the practice followed at each dam in aggregate adjustment.

At each dam there was a similar adjustment of mixer operation to meet the requirements. The mixers ran normally at about 10 r.p.m., but the number of revolutions for which the batch was held in the mixer was varied up to 25 as was necessary to secure the required perfection of mixture. Similarly, the volume of mixing water was varied by observation, accordingly as the sand came wet or dry from the bins and as the flow was sluggish or rapid in the distributing chutes.

Output capacity and reliability of operation were especially essential in the concrete haulage methods. To clear the way for hydraulic filling, the outlet concreting was scheduled to continue through the winter and to maintain a rapid rate of progress. The lengths of concrete haul from mixer to place were from 600 ft. to 1600 ft., maximum. Distribution by chuting without hoisting was made possible by the topography at Englewood and Germantown, while at the other dams the outlet location and the type of structure made derricks, as explained later, the logical equipment for distribu-



DRAGLINE EXCAVATES EMPLACEMENT JUST IN ADVANCE OF CONCRETING AT HUFFMAN

tion. All these conditions appeared to be best satisfied by industrial-railway haulage. The equipment selected was 30-in.-gage track and friction-drive gasoline locomotives. Flat-cars carrying buckets were used for

OUTFIT FOR DIRECT CHUTING FROM CARS AT ENGLEWOOD

derrick distribution, and side-gate hopper-body cars where the concrete was chuted.

Two- and three-car trains were operated by single locomotives, each car carrying a batch of more than 1 cu.yd. On interrupted work an outfit of three locomotives and six to eight cars regularly handled 300 cu.yd. a day, and on occasions a single locomotive handled 200 cu.yd. a day. Weather conditions such as prevailed during the mild winter of 1918-19 did not materially affect the haulage operations.

At Englewood and Germantown the twin outlet conduits, about 1000 ft. long, were located in trenches parallel to and at the bottom of bluffs. By placing the mixing plants on the bluffs and laying the industrial tracks along the sides above the conduits, provision was made for direct chuting from cars by means of the simple chute traveler outfits described in *Engineering News-Record* of Mar. 20, 1919, p. 588. At Germantown practically all of the 15,368 cu. yd. in the conduits were placed by direct chuting from cars standing on the track. Near the upstream ends of the Englewood conduits, where the bluff was not high enough for direct car delivery to the chute traveler, a locomotive crane lifted the cars from the rails and swung them into discharging position over the chute hopper. Also, where the very upper ends of the conduits came to a point nearly opposite the mixer, a hoist tower and chute were installed in place of cars and chute travelers.

Instead of building twin conduits low on the valley bottom, as just described, the concreting problem at Lockington, Taylorsville and Huffman was to build parallel retaining walls 70 to 80 ft. high from the valley bottoms to the crests of the earth dams. Topography did not permit direct chute delivery from cars. Since derricks were necessary to handle the wall-form units and would serve other useful purposes in preparing the emplacements, decision was made to place the concrete by derricks. The outfit at Lockington was described in *Engineering News-Record* of Feb. 13, 1919, p. 327; that at Huffman was substantially similar.

Similar procedures were followed in concreting outlets of corresponding types. The twin conduits were built in sections, first sections of the lower half of the conduits closely followed by corresponding sections of the upper arch portions using knockdown forms of wood. Both walls of the open channel outlets were concreted at the same time, proceeding from one end to the other by successive sections and using wood-form panels. Placing methods followed usual good practice.

Progress of concreting at the four dams is comparable only in the most general way, owing to differences in the types of structures and in the outfits employed. and particularly to differences in the conditions and the necessities of the work. Winter concreting was continuous at all of the dams except Huffman, which was not begun until March, 1919, but, owing to the mildness of the season, only very ordinary cold-weather precautions, as described in *Engineering News-Record* of Mar. 27, 1919, p. 618, were necessary.

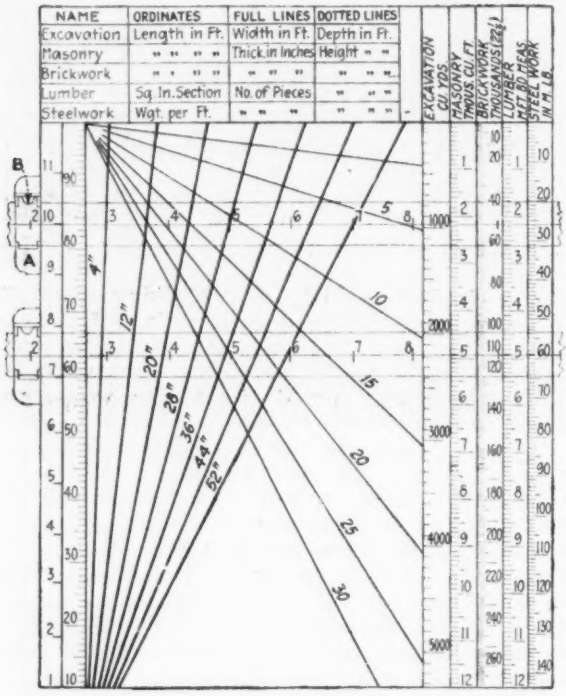
Considering the four dams separately, the significant progress data are as follows: Concrete placing was begun on the same date, Aug. 10, 1918, at Englewood and at Lockington, and the dates of completion were, respectively, June 7, 1919, and May 27, 1919. At Englewood between the dates named 19,000 cu.yd. were placed, or about 2000 cu.yd. per month, mostly in arch conduits. The Lockington work required 206 actual working days for 28,223 cu.yd. in retaining walls and floors, or an average of 3000 cu.yd. per calendar month. The best day's record was 367 cu.yd., and the best record for one week was 1570 cu. yd. At Germantown 15,368 cu.yd. were placed in a little over seven months between Oct. 5, 1918, and May 10, 1919, or about 2200 cu.yd. per month. At Huffman, from Mar. 7 to July 16, 1919, 20,700 cu. yd. were placed, or about 5000 cu.yd. per month. In June the output was 6000 cubic yards.

The outlet construction was under the general direction of Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager, of the Miami Conservancy District. Direction of the operations at the various dams came under the division engineers: Arthur L. Pauls at Germantown; H. S. R. McCurdy at Englewood; Barton M. Jones at Lockington; O. N. Floyd at Taylorsville, and C. C. Chambers at Huffman.

Mechanical Device for Reading Curves and Tables

Simplifies Determination When Charts Require Simultaneous Readings of Several Elements—Charts Cleared

COMPUTATION of quantities by the use of curve charts and taking figures from tables, is simplified by the use of the device shown herewith. The principle utilized is the mechanical setting and transferring of one or more of the elements by T-square. This not only



METHOD OF USING MECHANICAL DEVICE FOR READING COMPLICATED CHARTS

eliminates the necessity for keeping two or three elements in mind at once and tracing the various ordinate and curve lines with the eye, but also clears up the sheet by the omission of the generally used squared ruling.

It is well known that curves are a superior form of aid to the engineer, but the difficulty encountered in reading two and often three elements, found in different directions, has limited their use to simple forms consisting of one series. If two or more series of interdependent curves could be easily read, often a great deal of tedious labor could be saved.

A chart of the complicated character mentioned is shown in the accompanying illustration, with a mechanical T-square device for reading placed thereon. This device consists of a cross-head A, made of metal or wood, about 2½ in. long, a metal holder B containing a spring, and a transparent arm C about 12 in. long, made preferably of celluloid. The arm has a numbered horizontal line through the center, which may be made to cover any desired abscissa of the chart. This arm slips freely through the head, so that when the instrument is used the index points may be moved to coincide with any desired point of the chart.

In using the instrument, it is convenient to pin the curve sheet to a drawing table or have it glued upon a small board made for the purpose. It will be noted that the chart shown in the illustration may be used to estimate excavation, earthwork, brickwork, lumber and steel, after the necessary dimensions are taken off. Thus, if a 28-in. brick wall is 84 ft. long and 25 ft. high, the number of brick would be found by bringing the horizontal line of the arm to cover 84 in the second left-hand column, sliding the arm until any numbered point covers the solid-radial line 28 and then dropping the T-square to the second dotted position, so that the same number covers the dotted-radial line 25. The number of brick may then be read at the right under brickwork as 110,000. To perform the same operation by the eye, it would be necessary to have the sheet closely cross-ruled in both directions and to follow carefully the cross-lining around the circuit.

Laying out curves may also easily be accomplished by having a pin-hole through the arm at one of the numbered points, such as 7, so that by knowing the ordinates of the point the square may be set and a hole punched.

A continuous type of instrument arranged on the principles stated above, but in cylindrical form, mounted on a shaft and turned by end knobs, has been devised by Samuel N. Polis, a consulting engineer of New York City. The cylinder is 8 in. in diameter and 18 in. long, and is designed to take charts 18 x 24 in. in size, thus giving greater accuracy. Various curve sheets of this size can be easily clamped down on the cylinder when needed. Patents have been filed covering this construction.

Assessment for Water Main Extensions in Los Angeles, California

FRONTAGE assessments for water-main extension in Los Angeles, Calif., are charged against property owners at the rate of 40c. per front foot wherever the extension is not more than 200 ft. in length for each permanent consumer. For all pipe on a given extension in excess of 200 ft. per consumer a deposit of 80c. per lineal foot is required, the deposit to be refunded in equal annual installments as the frontage charge first described is paid. No pipe across a street intersection is included in the measurement for assessments.

In case of extensions made solely for irrigation (there being large irrigated areas supplied from the Los Angeles water-works) a different rule prevails. Where the extensions are into districts which issued bonds for trunk lines, lateral extensions for irrigation only will be made on payment of deposits equal to the full cost of the proposed mains, based on estimates made by the Department of Public Service. These deposits are returnable in five-year payments. Persons other than the original depositors may obtain connections by depositing a sum in the same proportion to the amount of the original deposit as the area they desire to have served bears to the total area served by the extension. These deposits also are subsequently returned by the city in five-year installments.

Lands not assessable for irrigation service provided by district bonds may obtain water for irrigation by agreeing to pay $35 per acre of land to be served, not less than 10% down and the remainder in not over

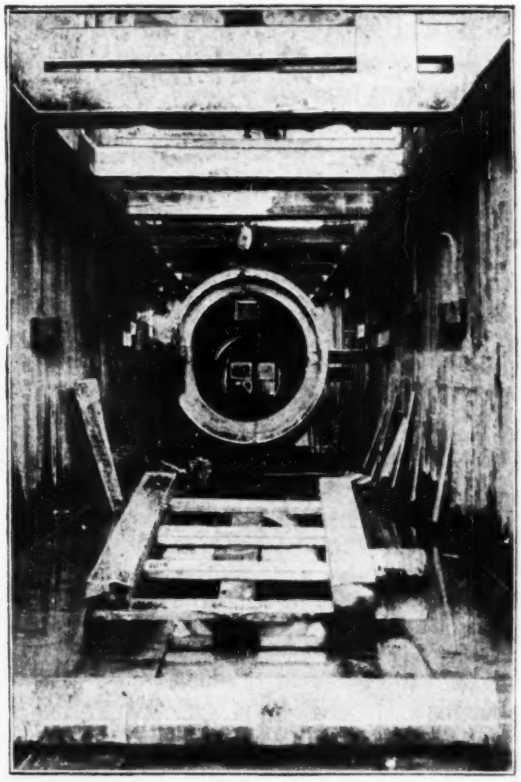
nine equal annual installments, with interest at 6% on deferred payments; or if the payments are made in advance, either for the total or any deferred sums, a discount at 5% is allowed. This class of assessments is in addition to the usual charges for water-main extensions and service installations.

Drainage Culvert Built Through High Railway Fill

Small Cars Operate in 41-Foot Trench—Concrete Pipe Laid on Concrete Floor—Piles Carry Track—Cost of Work

TO PROVIDE an outlet for a drainage system serving 10,000 acres of land in Yakima County a 48-in. pipe culvert had to be built in a cut 41 ft. deep through a high embankment of the Union Pacific R. R. near Granger, Wash. The first step was to drive 65-ft. piles in the center of the fill on each side of the proposed cut. This was done with a railway piledriver, after which caps and stringers were laid to carry the track. Sheeting was placed behind the piles to hold the material as excavation progressed. Beyond the piling, through the slopes of the fill, cribs were built at the sides of the cut, the piles and cuts being braced by 8 x 8-in. timbers 14 ft. long. This method was used to carry the excavation down to within 8 ft. of the grade of the culvert, at which stage a new set of timbering and sheeting was started through the entire length, reducing the width to 8 ft. For the upper lift the sheeting was driven by hand. In the lower lift the material consisted of volcanic ash in solution, which is practically the same as quicksand. Here the work was expedited by using a water jet, and the sheeting was pushed into place by hand. The excavated material was shoveled into steel dump cars having removable hopper-shaped bodies of ¾-yd. capacity. These cars were run out to one end of the cut, where the bodies were raised and swung by the 60-ft. boom of a dragline excavator, the material being dumped on the right-of-way.

CULVERT TRENCH FINISHED FOR FIRST LIFT, 14 FEET WIDE



METHOD OF INSTALLING PIPE

During the construction of the drainage culvert, a stream of 6 cu.ft. of water per second was diverted through an old culvert 25 ft. distant from and 6 ft. above the bottom of the new structure. This necessitated the use of double sheeting to prevent the water from breaking through into the new excavation. A 5-in. and a 4-in. pump, both electrically operated, were used during excavation of the lower 8-ft. lift. A heavy bed of gravel was placed in the bottom of the trench, and on this was laid a 12-in. slab of concrete. The 4-ft. reinforced-concrete pipes were laid on this slab, the joints being cemented and a cradle of concrete built around the pipe. Finally, the trench was backfilled, the timbering being removed during this operation. The cost of the work is shown in the accompanying table.

This culvert was built under the direction of J. O. Greenway, drainage engineer of Yakima County, Yakima, Wash., with Carl E. Beam as engineer in charge of construction. The contractors were Carson, Chindahl & Co., Spokane, Wash.

COST OF BUILDING CONCRETE PIPE CULVERT THROUGH RAILWAY FILL

Excavation, 2065 yd.	$0.89	$1,895.13
Bulkheading, lagging and piling, including cost of railway labor and equipment, 56,989 ft.b.m. in place	42.20	2,491.22
Concrete, 122½ yd.	9.35	1,048.54
Pumping, 74 shifts	5.34	397.07
Concrete pipe, 48 in., 100 ft.	9.33	933.51
Removing lumber, backfilling and puddling, 1200 cu.yd.	.56	677.29
Total		$7,442.75

Vermont Organized Into Health Districts

Under legislation effective July 1, 1919, the State of Vermont has been organized into 10 health districts, each in charge of a full-time health officer. These men receive $2500 a year and are allowed $800 additional for traveling and other expenses. They work in collaboration with the United States Public Health Service, having in that capacity the title of assistant collaborating epidemiologist, United States Public Health Service.

The Public and the Engineer

A Discussion Regarding Insufficient Compensation of Engineers, Their Relation to Public Affairs, and the Oversupply of Engineer Graduates

By Charles Hansel
Advisory Engineer and Investigator, New York City

THAT the worth of the engineer is not recognized, is the main theme of the complaints which have been appearing in the technical press and elsewhere. The last article of this nature appearing in *Engineering News-Record* of July 17, 1919, p. 125, under the title, "Why Engineers Are Not Appreciated," attempts to give seven reasons as follows: (1) Inadequate compensation; (2) lack of organization; (3) lack of initiative in public affairs; (4) lack of publicity concerning the engineer and his worth, and his relation to the better health, comfort and welfare of the community; (5) lack of proper regulation in the form of licensing; (6) improper application of the definition of the term "engineer"; (7) lack of general education and inability to speak well.

Other Professions Overcome Handicaps

The writer is firmly of the opinion that specifications 1, 2 and 4 bear alike on all professions, but that other professions rise above any handicap which may attach to the three specifications named. It has not been demonstrated that the compensation of ministers of the gospel, medical doctors, teachers in schools or colleges or even the average lawyer is greater than that of the average trained engineer, and certainly the engineering organizations are as strong in the advancement of technical knowledge as are those of any of the other professions.

If specification 2 is intended to refer to "organization" for the purpose of obtaining higher pay for the engineer, then the engineering profession, other than the American Association of Engineers, is in the same position as *all other* technical professions, for none of such has organized to insure higher compensation. The writer is as desirous as any other engineer to see his elected calling ranked with the highest, but he realizes that technical knowledge is far from being sufficient to warrant the highest award in the supreme court of public opinion. To obtain this high award of merit, the engineer must equip himself with knowledge of public affairs and material progress, and, having thus fitted himself for creative work, he must give of his thought and of his time to looking upward and doing his share toward public service. This thought is glimpsed in the third specification, but it is the cogent reason of all, and, like drainage to a railroad, it is the first, the second, the third and all-important specification which, if fully carried out, will lift the engineer into the class of leaders in the business of developing the materials and forces of nature for the use of men. Unless the engineer thinks and works beyond the technique of his profession and does not leave to others the creative thought, he becomes no more than any other machine which the man who does create finds it necessary to bring to his assistance and discards when the work is finished.

The public has decided that all technical professions shall receive less remuneration than nontechnical business men, brokers, bankers, managers and the like are able to obtain. Many engineers deem it unprofessional to apply their time to other than purely technical subjects, and many such have achieved a high place in public esteem and have won a reasonable compensation. Compared with the total number of practising engineers, these few successful technical engineers rather prove the exception to the general achievement.

The lawyer, when graduated from a university, has probably expended about the same amount of time and money as the engineer who receives a university degree, but the lawyer who achieves *marked success* generally broadens his training, by dealing with business and public affairs, more than does the engineer. Thus the lawyer merits and wins the highest places in Federal, state and city government, because he has demonstrated his knowledge of affairs, both public and private. Thus we find the legal profession dominating the affairs of the world. The successful lawyer omits no field of study, no proper advantage is lost to him; to his granary flows the knowledge of all classes of technical and business students. Practically all of our statesmen, high-class politicians (and some low-class), business men, doctors, many bankers and men of large affairs are lawyers.

The doctors, dealing with the human side, and the minister of the gospel dealing with the highest and best thoughts of man, do not "lack appreciation" in the sense of receiving the loving respect of their fellows, though they are often poorly rewarded in material things. The doctor serves many without price; the minister serves all without thought of the world's reward.

Where Does the Engineer Stand?

Where does the engineer now stand in the affairs of the world? It is true that every step of material progress demands his direction else it falter and fail. All other professions require the technical knowledge in order to carry on the world's work, and it appears that the engineering profession, generally speaking, has until lately been content to design and construct works which have been conceived and financed by others, and so long as the engineer remains content to be merely the aid, tool or machine used to carry forward the material progress of the world, he will surely be left in the unnoticed niche where he has chosen to stand.

It would be interesting to know what per cent. of the total membership of the civic organizations and chambers of commerce were engineers, or, put another way, how many members of the four national engineering societies are active in public affairs.

These national engineering organizations appear to have realized that they have lagged, and the committee on development, created by the American Society of Civil Engineers, in its progress report made in June directs attention to the need of engineers becoming active in civic work. The report says:

> The engineering profession owes a duty to the public which it is believed can best be discharged by the active participation of every engineer in the civic work of his locality. To this end it is urged that the engineer join the civic body of his community, and if there be no such organization, that he should then endeavor to organize the community for civic work in sympathetic coöperation with the governing body. The engineer's duty to the public also requires that he give his best efforts to matters of state, interstate and national character, calling upon the various engineering bodies for assistance and coöperation when necessary.

One difficulty attendant upon the work of the engineer is that his work requires the expenditure of money and offers little opportunity for demonstrating that it directly increases earnings. This is particularly true of railroad and city engineers and in most cases of bridge, tunnel and waterworks engineers.

Without desiring to pursue the many angles of the matter further, it seems evident that, considered as members of a profession, some engineers should receive as much as or more than members of other professions. It also seems evident that in order to bring the engineering profession more intimately into the big affairs of the world, engineers as a class must enlarge their training beyond technical matters, and give of their time at least as much as others do to the public affairs of the community, state and country.

The American Association of Engineers and the Union of Technical Men are urging upon the railroads, the municipal authorities, and others, the necessity for increasing the pay of engineers, and it is to be hoped that their efforts will be successful. It does not appear, however, that any success which may attend the efforts of these organizations and others in respect to increase of pay will necessarily advance the status of the engineering profession, and it is not unlikely that the result will tend further to classify the members of such organizations more as artisans than technically trained engineers.

The use of the title "engineer" is open to any person desiring to use it, even though engineers may be licensed to operate in certain states under the title of "licensed engineer." Experience has proved that it is practically impossible to define the title "engineer," and in the opinion of the writer this will not be accomplished unless the four national technical organizations are empowered by state or Federal authority to determine who is authorized to use the term engineer.

It is probable that universities and other seats of learning would take issue with the suggestion that the output of engineers be reduced, and yet it appears that the most potent factor influencing the compensation of the engineer is the generous outpouring from our universities of young men bearing the title. The law of supply and demand applies with the same force to the output of our universities as it does to the output of our factories and other productive sources, and if it is a fact that trained engineers generally throughout the country are receiving a compensation so meager as to be insufficient to cover reasonable living expenses, as compared with other callings, or the pay of artisans, mechanics, etc., then it seems obvious that we should curtail the output. In so far as the universities are concerned, any reduction in the output of engineers can be accomplished in two ways; one by advising the students as to the economic situation affecting the pay of engineers, and the other by making the requirements of the course more severe.

Cost of Maintaining Horses per Day

The cost of maintaining horses is shown in the annual report of the Department of Streets, Sewer and Highway Cleaning of the City of Cincinnati for the year 1919. The average cost of feed per horse per day for all stables was 63.3c. This was divided as follows: Hay, 23.9c.; oats, 30.3c.; Nutritia, 8.4c., and oil meal, 0.7c. The total stable cost per horse, for all horses, averaged $1.10 per day.

Sextant and Stadia-Rod Method for Measuring Distance

Topographic Mapping of Alaska Coast Line Facilitated by Special Stadia—Accuracy Tested With Good Results

By B. A. Baird
San Francisco, Calif.

By means of a unique method developed during the work of mapping portions of the Alaska coast line, results comparing favorably with plane-table mapping have been obtained by the use of sextant and stadia rod. By readings taken so as to eliminate the errors due to index error of sextant and to parallax, it was found by numerous checks and by tests that accuracy entirely sufficient for the purpose can be attained. Furthermore, there are many advantages of the use of the sextant for mapping by this method.

During the season of 1901 (April to October) the writer was employed in making a topographical map of the shore-line of a portion of Prince William Sound, Alaska, for the United States Coast and Geodetic Survey. The method employed was that of taking all the angles with a sextant, and plotting the positions upon a sheet tacked to a board about 1 ft. square, which it was very convenient to carry around. For positions plotted from distant signals a three-armed metal protractor was used, but for all other cases a small celluloid protractor and tracing paper were carried along in the recorder's field book. The work, thus done in sections, was afterward to be transferred to the main topographical sheet. Some of the drawings were made to a scale of 1:20,000, and some 1:40,000, but in all cases prominent points or other features were located, and the shore-line between was sketched, the points determined being from 50 to 200 or 300 m. apart, according to the regularity of the shore.

Special Stadia Rod Devised

While successive positions could usually be plotted directly from horizontal angles, there were many cases where they could not or, if they could, only with the greatest difficulty. For this reason, a stadia rod was devised by which a position could be plotted by a direction and a distance.

Owing to the mechanism of the sextant, it was necessary to have the targets fixed upon the rod, and then, the distance between them being known, to construct a table giving the distances corresponding to the angles measured. By a simple computation it was found that with the targets 9.544 ft. apart an angle of 10′ of arc would represent 1000 m.; of 20′, 500 m.; of 100′, 100 m., etc. In other words, a distance of 10,000 m. was represented by 1′ of arc, and any other distance could be found in meters by dividing 10,000 by the number of minutes. By simple consultation of a table of reciprocals, a table of distances with the angle as an argument was made out.

Owing to the mechanism of the sextant, the image of one target must be exactly superimposed upon the other in an observation, and in order to get good results the two targets were made exactly alike and perfectly symmetrical. Moreover, when the direct image is clear, there is a tendency for the reflected one to be faint, and vice versa; and so it was found that a fairly long target, crossing well the line of division between the clear glass

and the mirror in the horizon glass, was essential.

By a little experimenting, it was found that a rod having two exactly similar 5 x 10-in. targets, with a strip of white in the center 1¼ in. wide, gave very satisfactory results, the greatest distance read during the season being 541 meters.

The sextant used was United States Coast and Geodetic Survey No. 108, reading to 10″ of arc. The field telescope was used for both horizontal and stadia angles.

Advantages of the Method

While it is not claimed that this method can compare favorably under ordinary circumstances with that of the plane-table, and most certainly not for inland topography, yet it possesses several advantages which in some circumstances make it highly efficient. Most of the shore-line surveyed by this method during the season consisted of bluffs, many of them entirely inaccessible, especially at high water, and affording few places where a plane-table could be set up without great difficulty. However, by this method, if either the observer or the rodman could get any foothold whatever, the work could be done. Observations were made from the boat if the rodman could get a standing place, and vice versa.

If neither could get a standing place, and if much of the shore-line were of such character, both observer and rodman could use boats, care being taken to make allowance for the distance from the bluffs in plotting the work, these distances usually being not over 1 or 2 m., however. Also, tangent lines and directions to various objects could be obtained from the boats almost as readily as from the land, except when the water was rough. In such cases the observer could, if convenient, plot his position from horizontal angles.

Another advantage that this method possesses over that of the plane-table is that the rod need not be held in a vertical position, but may be held horizontally, or in any inclined position whatever, provided only that it is held normal to the line of sight. On account of trees, bushes or other obstructions, it often happened that the rod had to be held in some such position. Again if the rodman is in the direction of the sun, and the sun is at any appreciable height, the rod may be held horizontally and the faces of the targets inclined so as to reflect the rays of light, making the observation easy, when otherwise it would be difficult. However, the work was usually planned so as to observe away from the sun as much as possible.

Sometimes, owing to the nature of the shore-line or the positions of signals, a traverse had to be carried a considerable distance before a check could be obtained. A notable instance of this was the traversing of the south side of Goose Island, where no land was visible within 20 miles, and where the bluffs and woods shut off everything from the other side. Some of the larger angles had to be divided into two parts by means of a distant mountain peak. In this work, although tangent and other direction lines were taken as far ahead as possible, the traverse was not made to depend upon the longest stadia distances obtainable; but, rather, the longer distances were made up of two parts, by having the rodman remain at an intermediate station while the observer occupied each of the terminal points.

Suppose, for instance, along a comparatively straight shore a distance of 400 m. is desired, and the seeing is not very good. For 400 m. the arc subtended would be 25′, and an error of 1′ would mean an error in distance of 16 m. By dividing it into two 200-m. readings, the subtended arc would be 50′, so that an error of 1′ would represent only 4 m. By addition of the two parts, the most unfavorable case would be an error of only one-half that of the one reading, and the probability is that it would be much less. Furthermore, to avoid accumulation of error due to plotting in such cases, the sum of the two distances could be first taken if the points were approximately in a straight line.

The accuracy of the sextant stadia method was put to many rigorous tests in the course of the work, in tying up to triangulation stations and other points determined in various ways. The author has since executed about the same amount of plane-table work, and considers the two methods roughly equal in accuracy, if done with like care. Careful tests up to 300 m. were made upon the Valdez base-line stakes. Using the average of sextant readings "on arc" and "off arc"—that is, sighting direct first at one of the two targets on the rod and then at the other—the results showed exact agreement at the 200-and 250-m. stakes, a distance by stadia of 50.1 m. at the 50-m. stake, of 99.8 m. at the 100-m. stake, of 149.5-m. at the 150-m. stake, and of 298.9 m. at the 300-m. stake. The average of the reading "on arc" and "off arc" eliminates the index error and the parallax, and the results are seen to be quite satisfactory.

Another Diagram for Solving the Manning Hydraulic Formula

By R. D. Goodrich

Engineer in Charge of Works, Commission for the Improvement of the River System of the Province of Chihli, Tientsin, China.

THE writer was much interested in the diagram for the solution of the Manning hydraulic formula which appeared in a letter from Prof. M. F. Sayre in your issue of June 5, 1919, p. 1126.

This formula is especially useful for certain classes of work, such as preliminary computations, on account of the ease with which the solution can be made with some of the standard slide rules. Other advantages are the large range of conditions which can be covered in one diagram, the ease with which a diagram can be constructed, and the accuracy and rapidity with which more extended computations can be made by the use of logarithms and the tables which are now available.

While the Kutter formula, on account of its long standing, will doubtless continue to be the accepted formula for many purposes, such as final reports and legal work, the Manning formula should find a large field of usefulness as engineers become more familiar with it. It has been discussed and compared with other formulas in Parker's "Hydraulics," in King's "Handbook of Hydraulics," where tables are given for its solution, and also in Part IV of the Miami Conservancy District Technical Reports.

It is especially simple and useful when reduced to metric units. It then becomes $V = r^{\frac{2}{3}} s^{\frac{1}{2}} \div n$, in which the terms all have their usual significance. By writing it in the form $nv = r^{\frac{2}{3}} s^{\frac{1}{2}}$ it is an easy matter to construct a logarithmic diagram which will cover any required range of conditions.

The accompanying diagram was prepared to facilitate the hydraulic computations involved in the investigation of river and flood channels preliminary to the

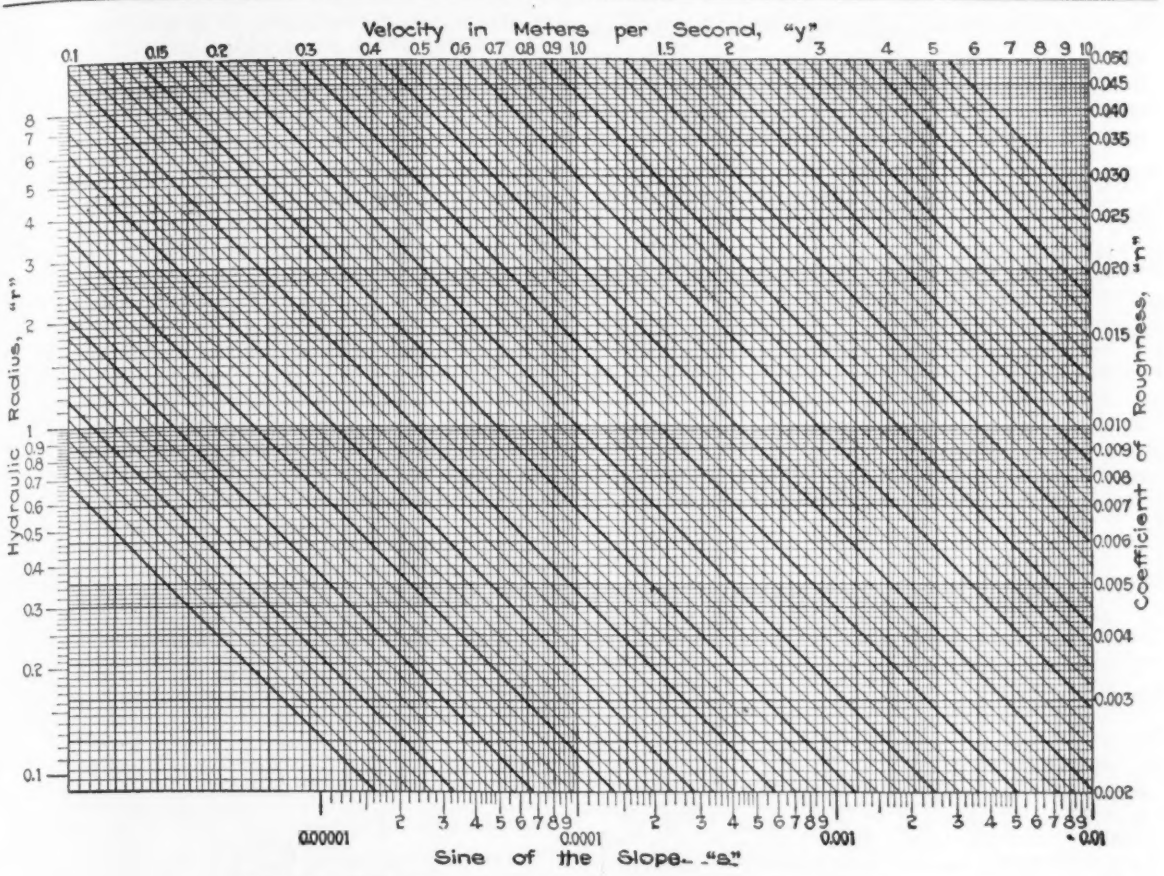


DIAGRAM FOR SOLVING THE MANNING HYDRAULIC FORMULA

design of the regulation of the river system of the Province of Chihli, China. To use the diagram, find the diagonal passing through the point of intersection of the ordinates through any given pair of values of r and s, interpolating as required. Any pair of ordinates for the other two factors, n and v, which meet on the same diagonal, will satisfy the equation. Hence, with any three of the factors given, the fourth can be found at once. It will be seen that the diagonal guide lines are all parallel at an angle of 45°, giving the best intersection with both horizontal and vertical axes, and that they are simply guides which may be drawn anywhere if the slope is always 45 degrees.

By shifting the r and v scales so that 1.00 comes at 0.305 on the scale, as shown, the diagram will give results in feet, or scales for both English and metric units can be included on the same diagram if required.

In some irrigation and drainage problems a certain slope is available, depending upon topographic conditions, and a value of n can be selected according to the material and alignment of a proposed artificial channel. It is then required to select the cross-section to fit the condition. For example, given a slope of 0.0004, with $r = 0.20$: By drawing a diagonal through the point of intersection of the ordinates through these quantities, at right angles to the guide lines on the chart, any pair of values of r and v whose ordinates intersect on this new diagonal will satisfy the conditions. By assuming the average depth of the channel equal to r as a first approximation, three or four trials will enable one to select a suitable cross-section for the proposed channel. If one has many such problems, a separate diagram can be prepared with diagonals running in the opposite direction to those in the figure, to solve the equation in the form $v \div r^{\frac{2}{3}} = s^{\frac{1}{2}} \div n$, or the other diagonals may be dotted in on the same diagram.

The diagonal running from the lower left-hand corner to the upper right-hand corner of the diagram has the slope required for the solution of the equation $y = r^{\frac{2}{3}}$ and is used in plotting the scale for r at the left of the diagram. The scale for s at the bottom was plotted in a similar manner; the ordinary 10-in. logarithmic paper, with scales in both directions running from 1 to 100, was used as the basis for the diagram.

The discrepancy between velocities taken from the diagram and those obtained by computation will average about 1%—seldom exceeding 2%—which is believed to be close enough for most work.

For hydraulic radii between 0.4 and 3 m., with slopes from 0.0001 to 0.01, this diagram will give practically the same results for all values of n as diagrams for the Kutter formula. It will also check very closely for flatter slopes when n does not exceed 0.015, and may therefore be useful in the design of sewers, aqueducts or irrigation flumes.

Federal and Provincial Housing Aid in Canada

Housing acts have been passed by a number of Canadian provinces to take advantage of a $25,000,000 Dominion appropriation. Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia are included in the list. The applications for loans made by 47 municipalities aggregated $10,000,000.

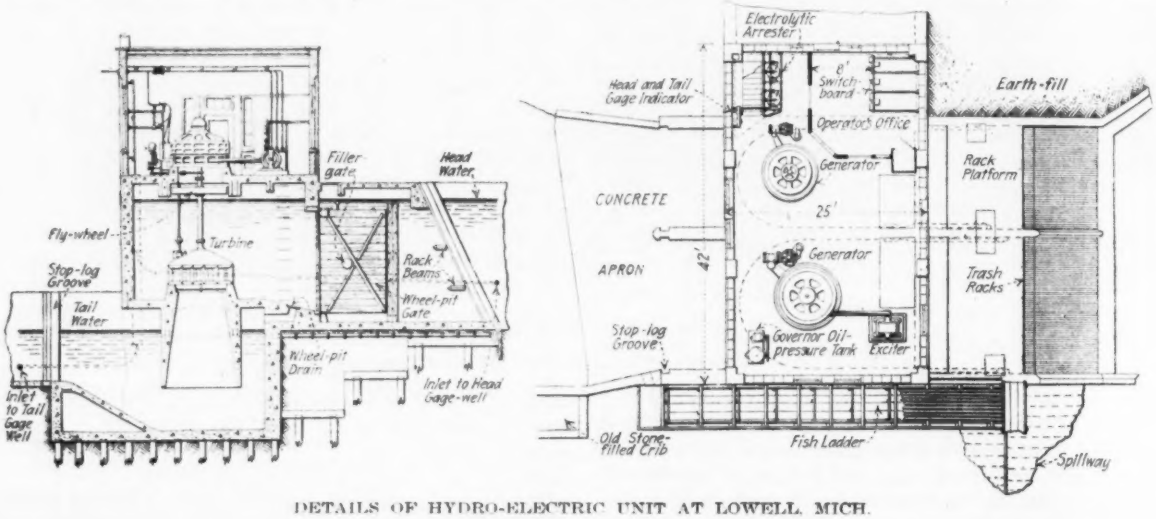
Solving Hydro-Electric Problems of a Small Town

Stable Unit Secured After Two Failures—Advantage Taken of Deep, Washed-Out Draft Pit To Use Vertical Cone Tube

EXPERIENCES of the Village of Lowell, Mich., with a small low-head hydro-electric plant—since, in 1896, it voted $23,000, purchased a power site on the Flat River nine miles above the town and built a plant and distribution system—cover two failures and a final high-grade installation recently completely costing $80 per installed horsepower. Features in the latest construction include a vertical cone draft tube dropping into a deep hole washed out when the old structure failed, and special sheet-pile connections between the concrete power house and a timber spillway as a protection in case the latter fails.

In the original plant a wooden power house on masonry walls was built over a timber flume adjacent to a wasteway and 200 ft. of timber spillway. The 13-ft. available head in the 50-acre pond was augmented by 2 ft. gained in excavating a 100-ft. tailrace parallel with the river channel. The equipment consisted of two units: one rated at 368 hp., owned by the village of Lowell, and the other, of 144 hp., owned by a private company in the Village of Belding. Lowell and the company shared the expenses of the operation and assumed the responsibility of the upkeep of their respective equipments. This arrangement as a whole was not particularly satisfactory, since the failure of one to keep its equipment in first-class condition resulted generally in waste of water, making the other insufficient to carry the load, although the stream should have yielded sufficient power under all conditions.

High water in 1901 washed out the spillway, but it was replaced immediately by a timber spillway of 200-ft. crest length, a reinforced-concrete flume and wheel pits, and a reinforced-concrete wasteway with steel Tainter gate 20 ft. long and 15 ft. high. In 1914 the wooden power-house superstructure was replaced with fire-resisting tile construction and a corrugated galvanized-iron roof. Two years later, without warning, the concrete substructure of the power house started to settle, and within a short time collapsed completely. The apparent cause was the undermining of the foundation walls, due possibly to the failure of the timber floor of the draft pit, resulting in an initial settlement permitting the final destruction by the escape of water from the flume under the foundations. Emergency service from the Consumers' Power Co. was arranged for, and the equipment, including generator, belts, governors, electrical equipment and superstructure building materials, was salvaged. An examination early in 1917 indicated 2-ft. concrete substructure walls heavily reinforced, but with the rods and I-beams not so placed as to develop maximum strength. The escaping water from the pond washed out a hole 8 ft. deep below the bottom of the original draft-pit floor. The concrete floor at the rack section at the upstream end of the flume was intact. It connected to the top of a 4- or 5-ft. length of wooden sheet piling, forming a cutoff along the upstream edge of the spillway and power



DETAILS OF HYDRO-ELECTRIC UNIT AT LOWELL, MICH.

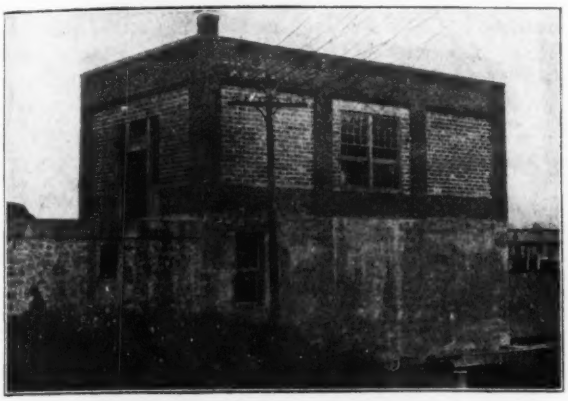
house. Apparently this was the only sheet piling used in the reconstruction of 1901.

In January, 1917, the village approved a $40,000 bond issue for reconstruction, providing for two generating units, the Belding interests to furnish one of them. Before the completion of the work the company was unable to raise funds for its unit, and the village purchased it with funds from plant earnings and tax receipts, entering into an agreement with the company by which the latter would purchase energy without a demand charge. But Lowell needs would take perference in case of a shortage of water. On account of the labor shortage and high prices, the contract was let on a basis of cost plus a fixed sum to the Hauser, Owen & Ames Co., Grand Rapids, Mich. This was in April, 1917.

Design of the power house was governed by the use of the site of the old construction in order to take advantage of the existing tailrace excavation. Preliminary studies of the stream flow and local conditions, to determine the probable economic development, indicated a plant capacity of 475 cu. ft. per sec. per square mile of drainage area. The normal head is 15 ft. To carry the probable load to the best advantage, one turbine was selected at twice the capacity of the other,

thereby obtaining high operating efficiency from one-sixth to full plant capacity. A 400-hp. vertical-shaft turbine drives a 280-kva. generator, and a similar 200-hp. unit drives a 165-kva. generator. Automatic oil-pressure governors control the speed.

Particular care was given to the design to prevent possible damage to the structure in the event of a failure of the timber spillway, the end of which connects with the substructure. The new structure rests on an 18-in. reinforced-concrete mat, 33 x 57½ ft. Under all bearing walls 30-ft. round oak piles were driven on 3-ft. centers. Along the side adjacent to the spillway are 20-ft. steel piles with the tops embedded in the concrete mat. Tongued-and-grooved 6-in. wood sheet piles of the same length were driven along the upstream edge to insure a cutoff of the water from the pond.



NEW POWER HOUSE FOR MUNICIPAL HYDRO-ELECTRIC PLANT, LOWELL, MICHIGAN

Reinforcing rods were placed in the draft-pit floor to withstand the upward pressure from the unwatering of the draft pit, and in the flume floor so that this will carry the load without the help of the backfill below it. As a precaution against upward pressure on the bottom of flume when empty, tile drains were laid in gravel beneath this floor; they discharge into the draft pit.

The location of the draft-pit floor at the elevation of the bottom of the washout resulted in its being 8 ft. below the normal tailrace bottom, and at least 6 ft. below the grade of an economical tailrace excavation. Advantage was taken of this rather deep draft pit to use a vertical cone draft tube. The water from the turbine rises in the pit around the tube to the tailrace level. Satisfactory results are reported, with power output very close to the Holyoke test of the type model.

Due to a marked increase in the efficiency of the units and from the method of operation, the plant has carried almost twice the load that the old one handled, and has not yet experienced trouble from shortage of water, which was formerly of yearly occurrence in the later summer and in the winter months.

For a total cost of $47,364 the itemized costs were as follows: Test pits and borings, $142; clearing site, $2836; cofferdams, $97; taking care of water, $2244; excavation, $1695; earth fill, $535; piling, $4553; concrete, $7382; reinforced steel, $2381; structural steel, $314; wheel pit gates, gage, etc., $1248; superstructure, $1643; equipment, $18,562; engineering and supervision, $3732.

The plant and distribution system are operated by Frank J. McMahon; Holland, Ackerman & Holland, Ann Arbor, Mich., were consulting engineers in charge of the reconstruction. The village trustees have been, in general, progressive business men, and as the results of a broad policy the citizens have enjoyed service at reasonable rates, and during the period have had consistently a low village tax rate.

Concrete I-Beams Used To Make Crib Retaining Wall

Combines Flexibility of Wood Crib With Permanence of Concrete—Developed on Cleveland Railroad for Soft Ground

PRECAST concrete I-beams of special section have been succesfully used in much of the grade-crossing work of the Cleveland & Youngstown R. R. for retaining and wing walls. The beams are interlocking, and they can be fitted together to combine the known flexibilty of wood cribbing with the permanence of concrete. The design was worked out by W. E. Pease, chief engineer of the railroad, in conjunction with N. H. Suloff, engineer in charge of construction, and W. H. Evers, president of the R. C. Products Co., of Cleveland, which made the units.

The Cleveland & Youngstown R.R. required the frequent use of retaining walls on fills and against banks containing springs. In one of the earlier grade separations, walls had to be built upon a fill over 20 ft. in height. To avoid either deep foundations or concrete piling, a wall was required that would be of sufficient flexibility not to rupture under settlement, and at the same time be economical in construction. To meet this condition, and also the situation where a wall would have to be moved to provide for future expansion, reinforced I-beams of a standard manufacture were used, and the joint shown in Fig. 3 was developed, this joint being accomplished by casting a locking lug on the bottom of the I-beam and placing stretchers on the edge. Lugs were cast on all members, the lugs being turned to the back where members were used for stretchers, thus permitting the use of any I-beam members as either a header or a stretcher, and the concrete members formed a flexible locking joint in themselves without the use of dowel pins or similar devices. To provide an even bearing, there was used a weak cement mortar which was not depended upon in any way for strength through adhesion to the members.

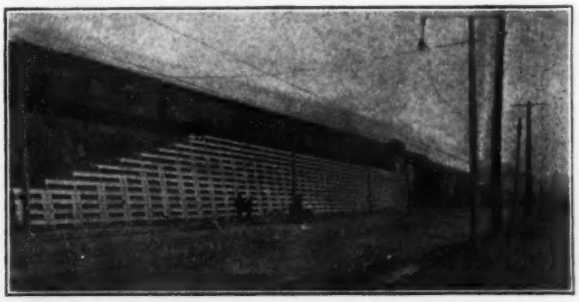


FIG. 1. LONG CONCRETE CRIB WALL AT PITTSBURGH AVENUE, CLEVELAND, OHIO

In the autumn of 1918 the structure shown in Fig. 1

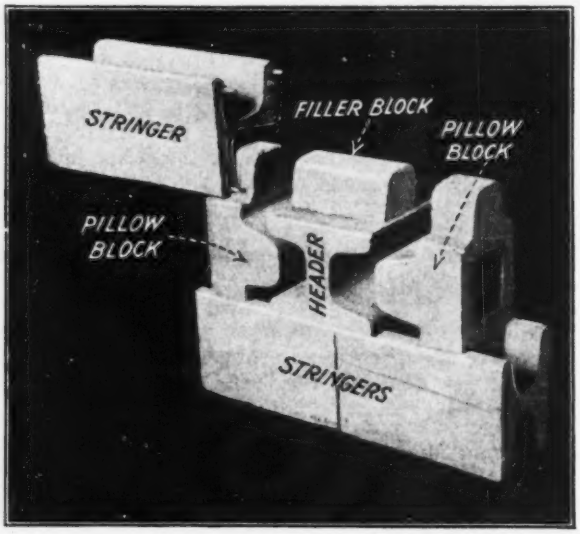


FIG. 2. MODEL OF CONCRETE I-BEAM FOR CRIB WALL

was erected. As some difficulty developed from the slight crushing of the headers along the bottom part of the face of the crib wall, the pillow block shown in Fig. 3 was developed, this not only reinforcing the header against crushing but also forming a lock be-

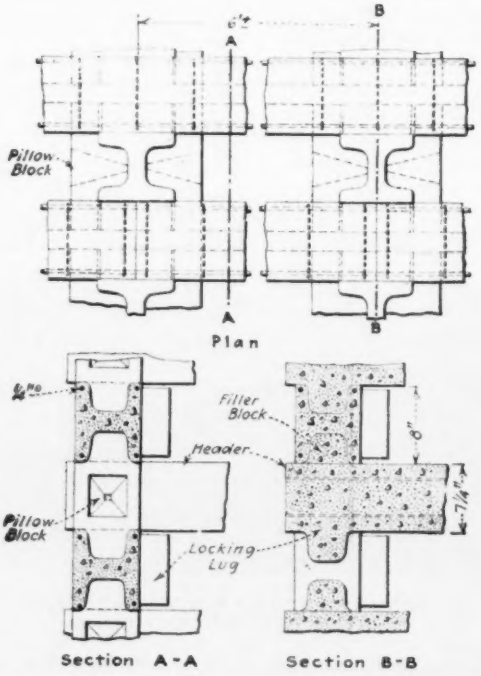


FIG. 3. DETAIL OF CONCRETE I-BEAM CRIBS DEVISED BY W. E. PEASE

tween adjacent stretchers. Together with the filler block placed on top of the headers, it formed a column 14 in. in width, which not only added to the strength of the structure but greatly improved its appearance.

The cost for the same heights of structure, exclusive of excavation, sheeting, backfilling and overhead charges, of the concrete crib was $25.01 per linear foot, while the mass concrete wall cost $55.11 per linear foot. As this construction proved so satisfactory both as to strength and cost, it was used in a later wall. Though this structure was constructed partly on a fill 40 ft. in depth, any movement is only detected by a close examination.

At the time when this work was going forward, the wall shown in Fig. 4 was erected. This structure was to act as a wing wall for the East 55th St. bridge in Cleveland, and is 35 ft. in height at the highest point. Attention is called to the top finish, along which it is very easy to cast a concrete coping if desirable. While this structure has been finished for several months, a recent examination showed no rupture or distortion.

The section can readily be altered to provide for local conditions. Headers may be spaced at any desired distance, and can also be extended back into the embankment from the back line of stretchers. At the critical points in the wall shown in Fig. 4 the headers were

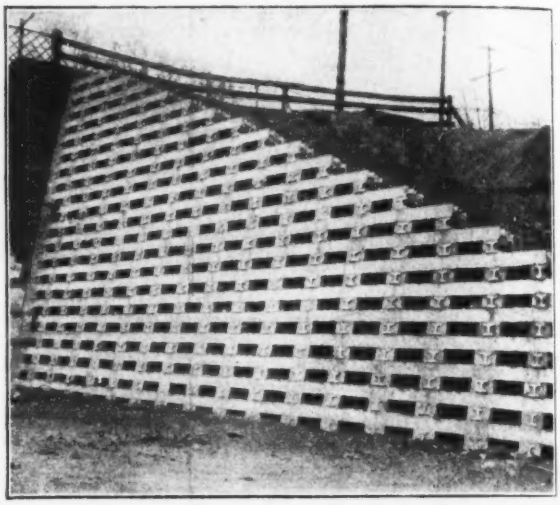


FIG. 4. CONCRETE CRIB WING WALL, EAST 55TH STREET BRIDGE, CLEVELAND

carried back 36 ft. While it is possible to cut these I-beams to any lengths in the field, it has been found well to have them cast in lengths of 6, 9 and 12 ft. As the beams used weigh only about 30 lb. per linear foot, the longest members can be readily handled by four men. In the walls erected no derricks have been used nor have they been considered desirable, as it is found that common labor takes a great deal of interest in these structures and much prefers working on them to working on ordinary concrete jobs.

Girder Expansion Bearing Fails to Slide

Expansion trouble with a small plate-girder footbridge is reported by the bridge division of the Department of Public Works of Pittsburgh. A footbridge of 70-ft. span on the line of Graham St. is flanked by a small concrete jack arch at each end, forming a short approach, intended apparently as an aesthetic feature of the design. These jack arches and the steps leading from them have been pulled away from their connections to the abutments, opening up cracks an inch wide. This was caused by the girder failing to slide on its expansion bearing, according to J. D. Stevenson, division engineer of bridges for the city. The expansion bearing plates are now rusted tight together. It is intended in the near future to remove them and substitute effective expansion bearings.

Notes on Army's Light-Railway Practice in France

Experience Indicates Field for Improvement in Certain Details of Construction and Equipment of Narrow-Gage Lines

By Paul McGeehan
Captain, Engineers, United States Army

The writer belonged to the 12th Engineers, one of the light-railway (60-cm. gage) regiments of the A. E. F., throughout its 21 months on the fronts of the various allied armies in France. The regiment first served with the British Army in Picardy and took part in the battle of Cambrai in November, 1917, and in the great retreat of March, 1918, when all of the tracks and railway equipment of the Third and Fifth British Armies fell into German hands. Later, the regiment operated with both the French and American Armies and took part in the battle of Saint Mihiel. The armistice found the regiment in charge of all the light railways in the Second Army area, using, besides its own personnel, about 4500 auxiliary troops in the various phases of operation, maintenance and construction. The criticisms found in this paper are intended to be constructive, and it is hoped that expressions of opinion from others will be elicited which will make for the improvement of this very important branch of military transportation.—Editor.

MOST of the troubles of light-railway operation have resulted from the lack of careful design of the railway system as a whole, and from the careless working out of the engineering details. A light railway is a particularly tender "plant," and unless the engineering problems are properly studied one is likely to find after the job is finished that he has built something that is almost useless. For instance, on the Toul front much light railway was built after the Saint Mihiel push, to connect the American system with the light railways captured from the Germans. In the hurry to make these connections, much of the engineering was apparently hastily done with the idea of getting immediate results. One line above the Pont de Metz had a 5% grade for about 300 ft. at a place where a longer and much lighter grade could have been used just as easily. At another place a "Y" connection was built on so steep a grade that it could not be used on account of the extra resistance of the sharp curvature which had not been compensated for. The grades at these two places so reduced the size of the trains as to make the line practically useless. Another connection had a short stretch on a very steep grade, rendering the whole track useless without reconstruction—and the men for the reconstruction were not available at the time.

Much of this line appeared to have been located by eye, without the use of instruments, and without the other careful methods of railway location found necessary in civil life. These connections had been built in record-breaking time, but the months of unsatisfactory operation that followed showed how much better it would have been to allow more time for the engineering details. As it turned out there was plenty of time, for these tracks could not be operated for more than a month on account of the lack of ballast.

There is no way to beat the careful methods developed in peace time for the location of railways, and the multitude of curves which are possible on the light railways make their careful location almost as slow and just as important as the location of standard-gage lines. Curves ought to be carefully run and profiles carefully studied with the idea of obtaining the best possible

A PETROL-ELECTRIC TRACTOR AND LIGHT-RAILWAY TRAIN SERVING THE A. E. F. IN FRANCE

grades. To the civilian engineer these suggestions seem too obvious to be worth mentioning; but entirely too many lines in France were laid out entirely by eye with the idea of "getting the boys to work."

Grades Should Be Compensated

All maximum grades should be compensated for curvature. It would probably be advisable to have some experiments made to arrive at a fair approximation of what this compensation should be. The curves of light railways are so sharp that the rules obtained from standard-gage practice are probably not applicable. Experiments to show the resistance to rolling friction on straight track should be made at the same time. Quite definite information about this resistance on straight, level track in average maintenance is necessary in order to approximate the pulling capacity of the various types of locomotives on the different grades.

There is one fundamental difference between the location of military and civil railways. In civil practice it is desirable to get as much of the line located on embankments as possible, in order to avoid the bad drainage conditions prevalent in railway cuttings. With light military railways you want to get a roadbed fit for operation at the earliest possible moment. This means that your embankments, thrown up usually by hand, will require a long time to settle and solidify. Your cuts, on the other hand, will be hard at once, so it is an axiom on such work to avoid fills and put as much of your track in light cutting as possible. This precedure is especially necessary on side-hill work.

The writer is familiar with a piece of track several miles in length built along the side of a rather steep cañon. On account of the necessity for haste in making the connection, the officer in charge yielded to the temptation of reducing his quantities by using the waste material from the cutting as part of the roadbed, thereby reducing the size of the notch in the hillside by more than half. In this manner the grade point came under the center of the tie, and when the trains came over, one end of the tie rested on the hard foundation of the notch in the hillside and the other on the soft, yielding material of the embankment. As a result the operation over this track was not at all satisfactory until long after the military necessity for this track had ceased to exist. The trouble with soft embankments, of course, would be partially eliminated if some method of rolling or tamping could be devised which would be available when needed and which would be practicable for use at the front.

Ballast

With steel ties a good quality of ballast is imperative. Their sharp edges cut in so that ordinary dirt ballast, so prevalent on the earlier railways of the United States, is out of the question. Cinder ballast is open to almost the same objection because not enough resistance is offered to the sharp cutting edges of the steel ties.

On the Second Army front before Toul most of the ballast was made up of cinders from a French manufacturing plant. The inutility of this material is illustrated by a condition which arose when some of these lines had become very inactive on account of the advance of the fighting front. On account of the material stored in the various dumps, it was necessary to keep these lines open, and to have working parties and station agents along them. This personnel had to be fed, and ration trains were run at intervals of several days. In order to get these trains through, it was necessary to feed ballast continually into the line. Ballast, even, had to be put under this track to keep the ballast trains themselves running. The fault lay principally with the steel ties, for wooden ties would not have had the sharp flanges to cut into the cinder ballast.

In this same area the Germans had all of their tracks ballasted with very hard crushed rock. After the Saint Mihiel push and later, after the armistice, great quantities of this ballast rock were found piled behind the enemy's lines. On account of the better ballast, we usually found their tracks better than ours.

The British used the local white chalk of Picardy for ballast. It was inferior on account of its softness, but it made a fine foundation when a thin coat of harder material could be provided for a top layer. This chalk, being pure white, made the tracks fairly shine in an airplane photograph. Most of the British tracks were protected from direct observation, but all of them were in the open where they were easily photographed.

It seems that the ease of construction of the light railways is their greatest protection. The cost of destroying them by shell-fire is much greater than the cost of repairing the resulting damage. During the terrible bombardment that preceded the German advance north of Saint Quentin Mar. 21, 1918, comparatively few shells were thrown at the light railways—except in yards—while the standard-gage tracks were hit enough to be put out of commission. From my observation, the light railways were fairly safe, unless under direct observation, even quite close to the front lines.

Rail

The light railways operated on rails varying in size from 8 lb., the lightest French rail, to 100-lb. rail taken from unused standard-gage tracks. The Germans had a 20-lb. rail with a high, narrow section. This rail probably made a good beam, but it was often criticised for having too narrow a head to engage the drivers. Either a 20- or 25-lb. rail with the American section seemed to be satisfactory. Both the French and the American rail came attached to the metal ties made up in 5-m. lengths.

Curves

The curves were all made with 100-m., 50-m. or 30-m. radius. Thirty-meter was the ordinary allowable maximum curvature, although it was said that the trains would go around a curve with a 20-m. radius. The writer saw some 20-m.-radius curves that had to be replaced. In order to construct the curved sections, half- and quarter-rail lengths were furnished to piece out the ends; in other words, to make the curves meet the tangents. In the hurry of tracklaying, these pieces were seldom available, so these sharp curves were usually several feet too long or too short. If they were too short, a sharp kink resulted at the end of the curve, and if they were too long a slight reverse curve had to be sprung into the tangent to get it to join up with the curve. Then, again, it often happened that curves of the radius desired were not available, and sharper curves had to be used. The same conditions were to be seen in French tracks after many months of operation.

With the British, where the use of wooden ties was almost universal, no such trouble was encountered. Rails were furnished bent to these same radii, but the use of wooden ties, loose rail and spike made possible the location of curves of any radius.

With conditions prevailing on the battlefield, which make imperative the use of such material as is available, wooden ties with separate rails allow much greater flexibility of construction, and, in my opinion, they should be adopted as American Army standards. The steel tie cuts the ballast too badly, and the built-up track sections are unsatisfactory on curves. Furthermore, you never have the sections of the exact size on hand when you are in a hurry to get a track built.

Track Laying

The probable reason for the existence of the built-up section is its apparent aid toward speed in track laying. If you have all the required sizes on hand and properly arranged, they undoubtedly lead to speed in this particular. But it is my observation that the main cause of delay in light-railway construction is the ballasting. It was impossible to use in France a track made of steel ties without considerable ballast, and this will be the rule throughout the world.

I have seen branches lie idle, literally, for months for the lack of ballast. The wood ties would require less ballast and would make a better track with an inferior quality of ballast. In dry climate or during ordinary dry weather, tracks laid with wood ties might get along with only dirt ballast; but with steel ties you could not get along without a good quality of ballast in any climate.

Tactical Considerations

Light railways are best adapted to short hauls. On account of the frequency of derailments and the slow speed of trains, they are unsuited to long hauls. In the Second Army area the light railways, including those captured from the enemy, extended for a distance of 50 km. north and south, and it was usually considered that several days were required to go from one end of the area to the other. For if your train itself were not wrecked it would be delayed by other trains wrecked in front of it. The long hauls should be made by the broad-gage trains, and the short hauls from the railheads, four to eight miles in the rear of the battle front, should be made by the light railways. Their comparative immunity from drawing fire is their excuse for existence in this zone.

The light railway is not adapted to open warfare. It was, however, an ideal method of transportation behind the lines in France during the period of trench warfare. During the German offensive of March, 1918, the lines behind the British Armies went out of business as soon as the retreat began and all of the energy of the light-railway forces was used in saving the equipment.

For stationary battle conditions, light railways were practically ideal. A single-track line handled 2100 tons of ammunition in a day while preparing for the Cambrai offensive of 1917, thereby taking 700 three-ton motor trucks from the already crowded roads. In this offensive the number of troops engaged was limited by the carrying capacity of the roads.

If the light railways were so useful in France, with the prevalence of macadam roads, how much more useful would they be in a country like America, where good roads are so few? Under these conditions of bad roads in this country, the use of light railways would increase enormously the number of troops and guns that could be concentrated on a given sector, and would give an enormous advantage to the belligerent employing them.

Gage

In the opinion of many officers and men, the gage of 60 cm. is too narrow. This gage had been adopted in the early part of the war, when the rolling stock was much lighter than that finally used; but when the larger Baldwin locomotives came into use with cars of 10-ton capacity it was obvious that a wider gage would have been better. The opinion was often expressed that 4 or 6 in. wider gage, with no increase in the weight of the rolling stock, should have been used. As it was, the number of derailments was almost a scandal. On one classic occasion at Tincourt, on the British front, all of the steam locomotives in the service were on the ground at the same time. Derailments were so numerous and the cause of so much loss of time that orders had to be issued to reduce speed to not more than eight miles per hour.

The narrow track was undoubtedly one of the causes of the excessive cutting of the steel ties into the ballast, on account of the leverage from the swaying of the high locomotives. With a slightly wider gage and greater speed, and, thereby, greater capacity of the railway system, fewer delays on account of derailments would undoubtedly have resulted.

Conclusions

1. Light railway systems should be designed and located with great care. Sharp curvature should be eliminated as much as possible, and limiting grades should be kept as light as possible.
2. Earth fills should be avoided in constructions under battle conditions.
3. Nothing but hard ballast should be used when steel ties are used.
4. Wooden ties are preferable to steel ties, because they allow of more flexibility in laying track on curves, cut into the ballast less and allow the use of poorer ballast. Nobody ever expects a war to last long enough for the ties to rot out.
5. Light railways are adapted to short hauls only.
6. Their principal value lies in their immunity from destruction from shell fire, for they can be replaced cheaper than they can be destroyed.
7. They are useful in "siege" warfare only. They are not useful in either advance or retreat.
8. The principal cause of delay in light-railway construction is the ballasting.
9. The gage is too narrow. It should be increased to 28 or 30 in., without any corresponding increase in the wheel loads of the rolling stock.
10. Light railways would be exceedingly valuable in a campaign in country where good roads were scarce, and would facilitate greater troop concentrations for offensive operations.

Water and Sewage Treatment in Vermont

The water-supply of Burlington is filtered and chlorinated, and that of Rutland is chlorinated. No other municipal water-supplies in the state are treated, and there is no municipal sewage-works in Vermont.

Unusual Design and Joint Details of 430-Foot Bridge

Heat-Treated Steel Eyebars and High-Carbon Steel Built-Up Members Used in Warren-Type Truss for Economy in Material

ECONOMY in the use of material was attained in the design of the Monongahela Southern Railroad Co.'s bridge at Coal Valley, Penn., by the adoption of built-up members of high-carbon steel in conjunction with heat-treated eyebars for end diagonals and lower chords, requiring special joint detailing at the lower chord pins. Exceptionally long panels of 43 ft., with deep stringers and floor-beams, made it possible to avoid the use of subdivided panels, a Warren single-intersection type of truss being selected. Expansion joints are provided in the floor steel by double floor-beams at two intermediate panel points, and in each panel of the solid concrete ballasted floor. An increase of 15.6% above the usual allowable unit stresses was permitted in the high-carbon steel, furnished under specifications similar to those for the steel in the Hell Gate arch.

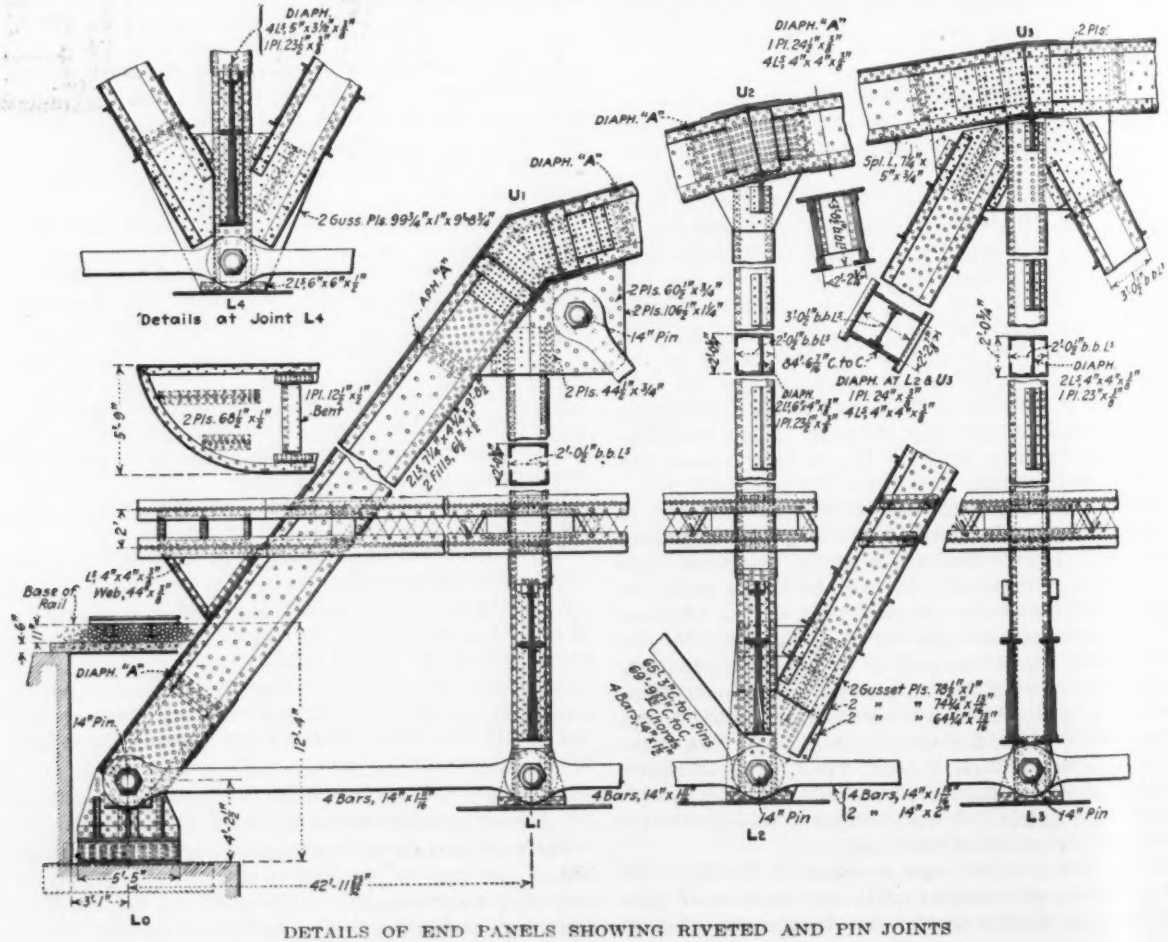
Loads and Unit Stresses—The dead load includes not only the solid concrete floor and ballasted track with steel ties, but footways on each side of the structure carried on cantilever brackets, and also two 40-in. gas mains. The live load specified is Cooper's standard E60 loading. The unit stress allowed in the special heat-treated steel eyebars is 27,000 lb. per square inch, with 30,000 lb. per square inch bearing on the carbon-steel pins. In general, a 15.6% increase over the usual A. R. E. A. specifications was used for working stress in the high-carbon steel. For combined stresses including wind the allowable units were increased 25 per cent.

On account of the high-unit stress in the lower chords, which produces excessive distortion in the floor system, the lower laterals were designed on a basis of 10,000 lb. per square inch unit stress, with a corresponding increase in the number of rivets, in order to give increased stiffness.

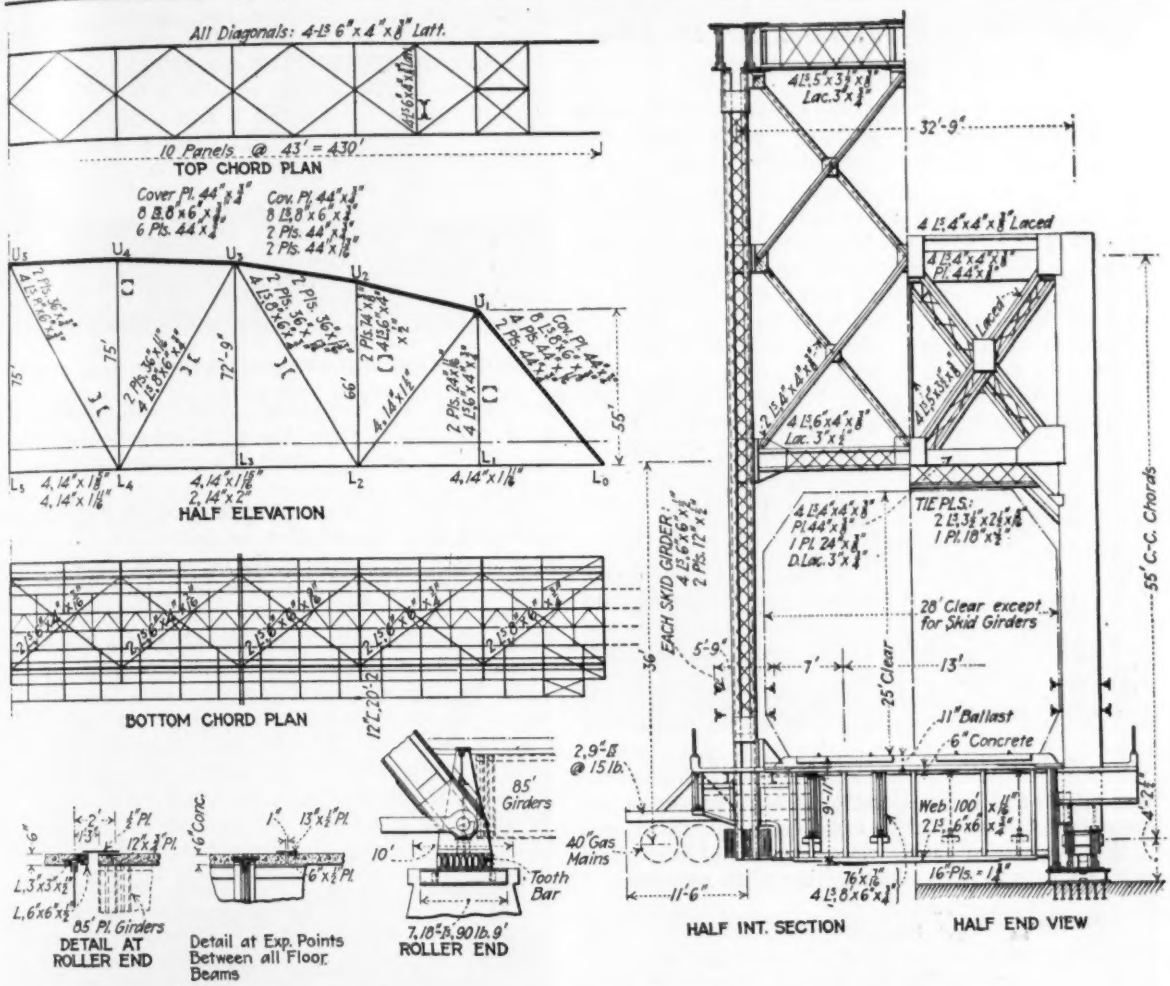
The special heat-treated carbon steel was required to satisfy the following specified limits: Phosphorus—basic steel, 0.04; acid steel, 0.06; sulphur, 0.05; ultimate tensile strength, 66,000 to 76,000; yield point, 38,000.

Special Joint Details—The use of eyebars and built-up riveted diagonals resulted in special joint details, as indicated on the typical details here reproduced; eyebars and the gusset plates for built-up web members had to be packed on the lower chord pins. Intermediate floor-beams are framed into the vertical posts as usual, except the double floor-beams at the two intermediate points L3, which are framed into the sides of the vertical posts.

The double floor-beams were introduced in order to allow expansion at these points, and also to prevent undue racking of the floor system from the elastic action of the lower chords under high unit stresses.



DETAILS OF END PANELS SHOWING RIVETED AND PIN JOINTS



HALF ELEVATION AND SECTIONS OF COMBINATION RIVETED AND EYEBAR TRUSS SPAN

The details of the expansion joint in the concrete floor are also indicated.

All main material was subpunched and reamed, and the main gusset plate edges were planed. The size of the field rivets in the main truss members was 1¼ inch.

In the top chords, built up of eight angles and web plates, it was necessary to insert the connection gusset plates between the inside flange and web, using filler bars between angle and web, with splice angles 7½ x 5 x ⅝ in. cut from 8 x 6-in. angles. Transverse stiffening diaphragms were placed on each side of the chord joints, as indicated; also short longitudinal diaphragms at the ends of the built-up web members.

Design of Floor System—The solid reinforced-concrete floor, with ballasted track and steel ties, is supported on deep stringers and floor-beams. The 43-ft. stringers are made up of 76 x $\frac{7}{16}$-in. web plate and four angles 8 x 6 x ⅝ in. and the intermediate floor-beams of 100 x $\frac{11}{16}$ web plate with four angles 6 x 6 x ⅞ in. and four cover plates 16 x ½ in. Footways are provided outside the trusses by cantilever steel I-beams, as shown in plan, using a 4-in. concrete slab. The 40-in. gas mains on one side are supported by channel cantilever beams with hanger plates and U rods.

Another exceptional feature of this bridge is the horizontal skid girders which are placed just above the floor system and are connected to the diagonal web members.

The object of these girders is to protect the main trusses in case a collision or other train accident should occur on the bridge.

The bridge was designed under the supervision of the chief engineer of the railroad company, and was fabricated and erected by the American Bridge Co., Ambridge plant.

Tests on Heartwood and Sapwood

No effect upon the mechanical properties of wood due to its change from sapwood into heartwood was noticed as a result of 300,000 tests which have been made at the Forest Products Laboratory, Madison, Wis. What differences there are in the strength between heartwood and sapwood can usually be explained by the growth and density of the wood. Differences between heartwood and sapwood, other than mechanical properties, are due chiefly to the fact that the sapwood of most American species is considerably less resistant to decay than heartwood, and, used without preservative treatment in situations favoring decay sapwood is likely to have much shorter life than heartwood.

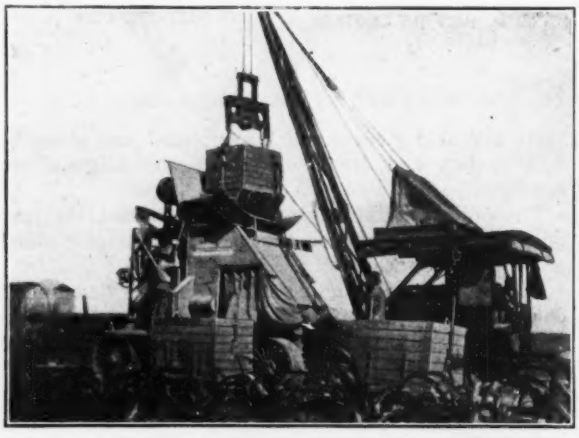
Large Paving Mixer Puts in 180-Yard Slab Every Hour

Bulk Cement Is Clamshelled From Gondola Cars to Bins — Boxes Carrying Proportioned Batches Crane-Charged Into Mixer

TEN-BAG batches were mixed and deposited at the rate of 47 cu.yd. per hour, in paving the Coldwater-Batavia concrete road in Michigan. Bulk cement, machine unloading, industrial-railway haulage of proportioned batches and crane charging, contributed to keep the big mixer supplied with material. A road-building outfit capable of quantity production was the object sought. With railway deliveries being made uninterruptedly, two 50-ft. sections of 5- to 8-in. slab, 16 ft. wide, were concreted every hour with a 12-man crew at the mixer. The construction of one mile of road a week, with continuous fair weather and a constant supply of materials, was demonstrated to be practicable with the outfit employed.

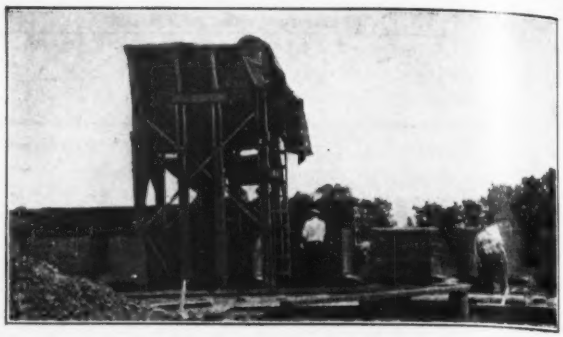
Approximately 6½ miles of 16-ft. pavement, 5 in. thick at the edges and 8 in. thick at the center, was built. The construction followed the Michigan state specifications, using a 1 : 1½ : 3 cement, sand and pebble concrete, and placing a ½-in. bituminous filler expansion joint every 50 feet.

Materials were delivered at Batavia, and placed on the contractor's private siding. There they were unloaded by a home-made locomotive crane consisting of a steam shovel, with a boom and clam-shell attachment, from which a ¾ cu.yd. clamshell bucket was operated. The shovel was mounted on a flat-car, with chains connecting the axle of the shovel to the axle of the car to furnish power to move the machine when required.



LOCOMOTIVE CRANE DISCHARGES BATCH BOXES INTO MIXER

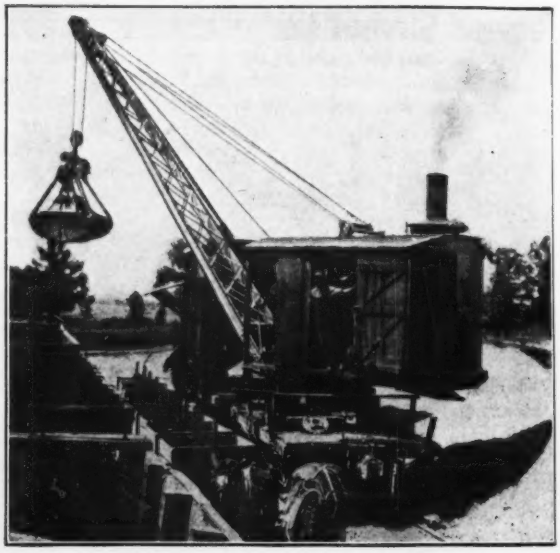
The unloading yard consisted of two standard-gage tracks 400 ft. long. On one track the cars of material were placed, and on the other the sand and stone hoppers, on railroad cars, with the crane operating between them on the same track. Placing of the storage bins on flat-cars so that they could be moved with the locomotive crane to any point where the aggregate was being unloaded proved very advantageous, as it was impracticable to get a switch engine to do switching sufficiently often to make possible the unloading of 500 cu. yd. of material a day. The 2-ft. industrial railroad connecting the unloading yard with the mixer



BULK-CEMENT BIN STRADDLES INDUSTRIAL TRACK

ran between the two tracks. The crane unloaded the sand and gravel from the standard-gage equipment into the bins or to a stock pile paralleling the crane track.

The cement was received in flat-bottom gondola cars, protected from the weather by tarpaulins. The clam-shell bucket that was used for unloading the aggregate picked up the cement and dumped it into the cement-loading hopper. This hopper was stationary and was set up between the two standard-gage tracks and astride



STEAM SHOVEL ON FLAT-CAR FITTED WITH BOOM AND CLAMSHELL FOR UNLOADING

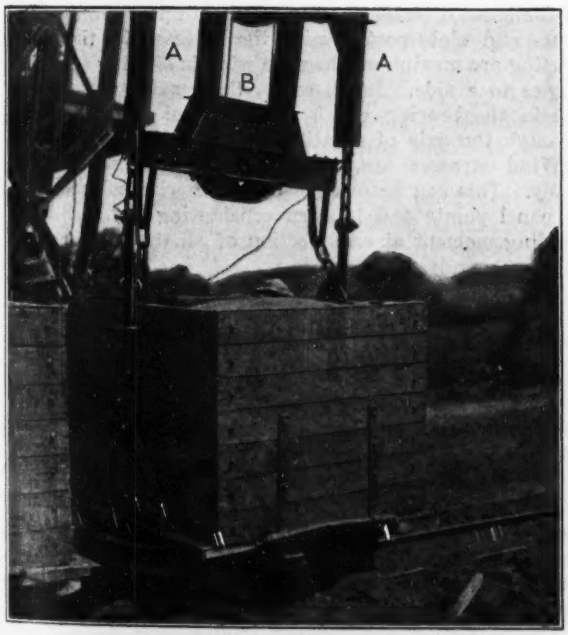
the industrial railroad. At first, question was raised as to the loss of cement by wind and of the danger of loss by rain, but experience proved that of the cement unloaded for about three miles of the work, the greatest variation between the quantity delivered to the work and the invoice quantity of the cement company was six sacks per car; the average was considerably less. No difficulty was encountered from wet cement or from storms, as the tarpaulins were lashed securely to the cars, and in case a car was not entirely unloaded in one day the tarpaulin covering was thrown over it at night. Two teams were used at the unloading yard for switching the industrial cars, and because of their ability to go to either end of a string of cars without loss of time, this method was considered preferable to the use of a locomotive.

The equipment used was standard 2-ft.-gage track

100 cars, and three- and six-ton gasoline locomotives. The cars each carried a one-batch box, with a capacity of approximately 55 cu. ft. They were handled in 15-car trains, when the three- and six-ton locomotives were doubleheaded, and in ten-car trains when the six-ton locomotive operated alone.

At the loading plant the proper quantity of stone was first put into the boxes, then the cement was measured by being passed through a cylinder holding 5 cu. ft. This cylinder was a 12-in. sheet-metal pipe, with a gate near the top and another near the bottom. The operator closed the bottom gate and opened the top gate, allowing the cement to run into the cylinder, and then closed the top gate and opened the bottom gate. This operation was repeated in order to get the right quantity of cement per batch. A piece of canvas attached to the bottom of the cylindrical chute and to a hoop on the other end, which could be lowered into the car and raised in order to let the car pass, did away with loss of cement by blowing. (As mentioned above, the loss in handling cement in this way proved to be less than one-half of 1%.) The car was then shunted to the sand hopper, where the proper amount of sand was added. The quantities used in the batch were 10 cu.ft. of cement, 15 cu.ft. of sand and 30 cu.ft. of stone. The trains were then made up preparatory to being taken to the mixer.

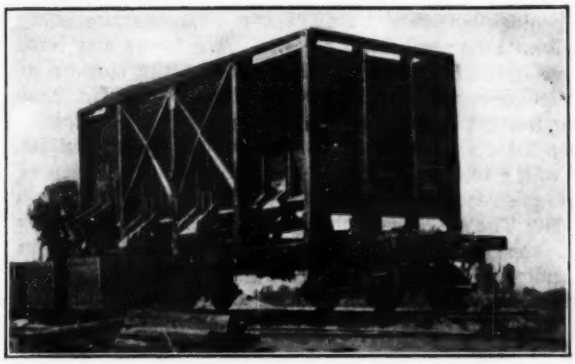
By the use of two locomotives double-headed, it was possible for the smaller one to handle the empties back to the loading plant, while the heavier locomotive did the switching around the mixer. Prior to the arrival of the locomotive, however, such handling of loads and empties as was necessary at the mixer was done by team. The usual procedure was for the locomotive to drop the loads at the siding, take out the empties and put in the loads. The boxes, which were designed with two bottom-dump doors, were picked up by a two-drum power crane. A steel bridle of channels and I-beams made it possible to pick up the boxes by irons attached to the door and swing them into place, and then, by releasing this line and picking up the line attached to the side of the box, to dump the box. (See illustration.) The crane, operating on "caterpillars" moving under its own power, furnished the traction for the mixer. By attaching the mixer rigidly to the crane, a constant distance between the two pieces of equipment was insured, overcoming the necessity of raising or lowering the boom. Experience showed that it was possible, with a minute mix, to put 25 to 30 batches per hour through the mixer.



SPECIAL YOKE LIFTS AND UNLATCHES BATCH BOXES

One drum hoists box by lifting on yoke A; to discharge the box a lift is taken by the other drum on yoke B and the line to yoke A is slacked off.

The mixer was of unusual size, built especially for the contractor, and with several features of his personal choice, by the Koehring Machine Co., Milwaukee, Wis. It is mounted on 4-ft. wheels with 20-in. treads, bringing the height of the charging hopper to 16 ft. and the height of discharge to 6 ft. With a 4-ft. 10 in. x 5 ft. 8 in. drum, taking a batch of 55 cu.ft. of dry materials, this mixer is nearly double the size of those commonly employed on road work. The mixer and placing crew consisted, as observed on June 21, of 12 men, as follows: One man operating the mixer; one man operating the hoist; two men handling boxes; one man handling empty cars with a team; one man operating the chute; two men distributing concrete; two men routing, and two men belting and rolling.



AGGREGATE BINS MOUNTED ON FLAT-CARS

The contractor for the work was G. L. Schart, Milwaukee, Wis.

Typographical Error Corrected

In the formula for stress in anchor bolts of steel stacks, given by R. Fleming in his article "Wind Pressures on Cylindrical Structures in Practice," in *Engineering News-Record* of Sept. 11, 1919, p. 499, the omission of parentheses in the denominator of the first term of eq. (10), p. 500, makes this term twice as large as it should be. The first term of the right-hand number of this formula should be identical with the right-hand side of eq. (9). In other words, the maximum stress in an anchor bolt is

$$S_a = \frac{0.106\, b\, M}{(2R)^2} - \frac{W}{N}$$

The reduction to eq. (11), however, is free from this error, and eq. (11) as given is correct, namely:

$$S_a = \frac{2M}{RN} - \frac{W}{N}$$

Wind Pressures and Wind Stresses in Tower Design

Towers for Water Tanks, Viaducts, Wireless Aërials and Power-Transmission Lines—Six- and Eight-Post Towers—Wind Pressures for Design—Working Stresses for Three Classes of Transmission Towers

By R. Fleming
American Bridge Company, New York City

IT IS PROPOSED in this article to give methods for determining stresses in towers due to wind. Towers as built for various purposes will be considered separately.

Water Towers

A water tower is an elevated tank and the posts or columns with bracing supporting it. The tank is cylindrical with a flat, conical, hemispherical or semi-ellipsoidal bottom. At present most tanks are being built with hemispherical bottoms. The tower may have three or more posts, usually placed at the corners of a regular polygon. The great majority of towers have four posts, though the number of posts largely depends upon the diameter of the tank. One well known builder of water towers uses six posts when the diameter of the tank reaches 35 ft. and eight posts when it reaches 50 ft. The 1,200,000-gal. tank of the Louisville Water Co., the largest of its type yet built, is 50 ft. in diameter, 90 ft. high, and 130 ft. from the hemispherical bottom to the ground; it is supported by eight posts.

The "Specifications for Gravity Tanks and Towers" of the mutual fire insurance companies contains a clause:

> Towers for supporting tanks of sizes up to and including 150,000 gallons capacity must have four posts. In those few cases where larger tanks are used, the towers may have six posts. Short towers for tanks on buildings may have three posts.

It is recommended that wind pressure on the tank portion be assumed at 20 lb. per square foot on the projected area of cylinder and 12 lb. per square foot on the projected area of roof and curved bottom. The 150,000-gal. tank of the New York Shipbuilding Co., at Camden, N. J., built in 1903 by the Chicago Bridge and Iron Works, is 209 ft. from the lowest point of the hemispherical bottom to the ground. The specifications for that structure provided for a wind pressure of 30 lb. per square foot "over half the diametral plane of the tank," and 200 lb. for each vertical foot of the tower; wind forces to be assumed in any direction, and members proportioned for the maximum stresses.

Wind stresses in the tank portion of a tower may be determined by the methods used for determining stresses in circular stacks.[1] The wind may be assumed to act at the centers of gravity of the respective areas. A vertical section through the axis of a tank with conical roof and hemispherical bottom shows a triangle for the roof, a rectangle for the cylindrical portion and a semicircle for the bottom. The center of gravity of the triangle is at one-third the height, of the rectangle at the center and of the semicircle at $0.424\,r$ below its top.

Where specifications require that towers be designed for a given pressure per square foot of exposed surface, the question arises, How much surface shall be considered exposed? The members of the windward face give but little protection to those behind them beyond breaking and dividing the air currents that pass through the tower. Furthermore, what is the amount of pressure when the wind is blowing in directions other than normal to the sides? An ample assumption for wind blowing in *any* direction is 30 lb. per square foot on 1½ times the projected area of the windward members on a vertical plane passing through the center of the tower and at right angles to the direction of the wind.

Because of the variation of members as to type and inclination to direction of wind, theoretical accuracy in the determination of pressure is impracticable. The writer in his practice assumes for ordinary water towers a total wind pressure (wind blowing in any direction) on the posts, bracing and riser pipe of 60 lb. $\times$ n, per lineal foot of height, n being the number of sides.

Wind stresses in any post are maximum when the wind is blowing in the direction of the diagonal which passes through that post and the center of the tower. This can be shown by passing a horizontal plane through the posts of any regular polygonal tower and treating the structure above that plane as a cantilever beam which tends to rotate about a center of gravity line (the neutral axis). The maximum fiber stresses are in the posts most remote from the neutral axis, and the distance is greatest when the neutral axis is at right angles to the diagonal.

Wind stresses in the side bracing of three- and six-post towers are maximum when the wind is blowing in the same direction as for maximum post stress. In four- and eight-post towers the stresses in the side bracing are maximum when the wind is blowing at right angles to a side. In all cases, the maximum stresses are in the bracing cut by the vertical plane passing through the axis of rotation.

Wind stresses are, preferably, determined analytically. This can be done by taking horizontal sections at panel points and in turn considering the resultant bending moment at each section of all the wind forces acting above it.

The maximum vertical component of wind stress in the posts directly above the section considered equals the following:

Three-post tower,	$M \div 0.75D$
Four-post tower,	$M \div 1.00D$
Six-post tower,	$M \div 1.50D$
Eight-post tower,	$M \div 2.00D$

where M is the wind moment about the neutral axis of the horizontal section passing through the panel point at the bottom of the post member considered, and D is the diameter of the tower at this panel point; that is, the diameter of the circumscribing circle of the polygon. The post stress equals the vertical component multiplied by the secant of the angle of inclination of the post to the vertical.

The maximum wind stress in diagonals (acting in tension only) equals the following:

Three-post tower,	$0.500\,(V - V')\sec\theta$
Four-post tower,	$0.707\,(V - V')\sec\theta$
Six-post tower,	$1.000\,(V - V')\sec\theta$
Eight-post tower,	$1.307\,(V - V')\sec\theta$

[1] "Pressure on Cylindrical Structures in Practice," *Engineering News-Record*, Sept. 11, 1919, p. 499.

where V is the vertical component of maximum post stress in the same panel as the diagonal, V' the corresponding value in the panel above the diagonal, and θ the angle which the diagonal makes with the vertical. The wind stress in any strut is approximately the horizontal component of the stress in the diagonal below that strut.

To illustrate the foregoing, refer to Fig. 1. Note

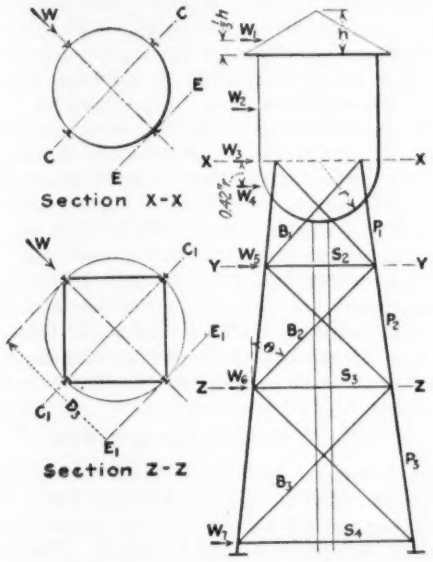


FIG. 1. FOUR-POST TANK TOWER

that the wind is assumed acting from the left in the direction of a diagonal of the tower.

Vertical component V_2 of stress in P_2 equals moment of W_1, W_2, W_3, W_4 and W_5 about axis CC in section ZZ divided by D_2.

Vertical component V_1 of stress in P_1 equals moment of W_1, W_2, W_3 and W_4 about axis through center of section yy divided by D_2.

Stress in diagonal B_2 equals $(V_2 - V_1) \times 0.707 \times \sec \theta$. (This is the *maximum* stress in the diagonal. The stress due to wind in direction W equals $(V_2 - V_1) \times 0.5 \times \sec \theta$.)

Stress in strut S_2 equals horizontal component of B_2.

The uplift should be determined similarly, the maximum occurring when the tank is empty. This method is not equivalent to equating moments about the tangent to the edge of the circumscribing circle (EE).

In designing the tank portion, the same working stresses should be used for wind loads as for other loads. In designing the tower portion, the specified working stresses may be increased 25% for combined wind and other loads, provided the section thus obtained is not less than that required if wind forces be neglected. The same result is reached in the Birch-Nord "General Specifications for Standpipes, Tanks and Towers," which uses 12,000 lb. for tension in tank plates, 16,000 lb. tension in other parts of the structure, and $16{,}000 - 70l/r$ for compression throughout, by the provision that stresses due to wind may be neglected if they do not exceed 25% of the combined dead- and live-load stresses.

Viaduct towers are usually made of four columns, braced transversely and longitudinally. The "General Specifications for Steel Railway Bridges" of the American Railway Engineering Association specifies transverse tower loads that represent a high wind pressure for unloaded condition and more moderate wind pressure for loaded condition, as has long been customary, but it adds for loaded condition a transverse force corresponding to the lateral impulses of the train:

Viaduct towers shall be designed for that one of the following loads, considered as moving, which gives the greater stress: (a) A force of 50 lb. per square foot applied on 1½ times the vertical projection of the tower and the portion of the structure which it supports.

(b) A force of 30 lb. per square foot, applied on the same surface, plus 400 lb. per linear foot of structure applied 7 ft. above the top of the rail, for assumed wind force on train, when the structure is loaded, on either one or both tracks, with empty cars weighing 1200 lb. per linear foot.

Wind stresses from the wind blowing in any direction other than at right angles to the longitudinal axis of the tower need not be considered. The dominant factor in designing the transverse bracing—for high towers, at any rate—is the amount of surface presented to the wind when the structure is loaded. The tractive force, usually assumed at 20% of the live load applied at top of rail, determines the longitudinal bracing.

The wind loads are assumed to be concentrated at the panel points. The diagonals are usually assumed to act in tension only. The chapter, "Stresses in Viaduct Towers" in Marburg's "Framed Structures and Girders," is exceptionally complete. It is believed these comments represent the best modern practice.

Radio Towers

The sole function of a radio tower (three such towers are shown in Fig. 2) is to provide a support for

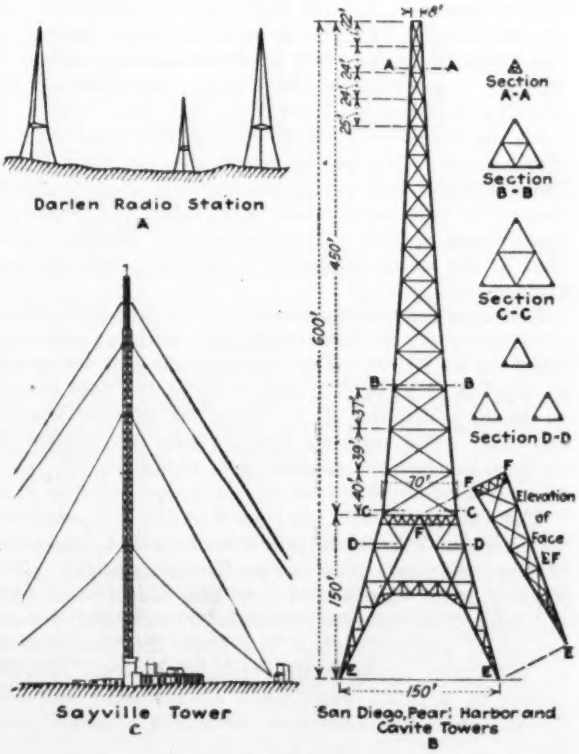


FIG. 2. THREE TYPES OF RADIO TOWER

an antenna or aërial of as large electrical capacity as possible and with its center of gravity as high as possible. The stresses from wind loads are greater than those from the dead load and are the dominating factor in designing the structure.

United States Government specifications for a 200-ft. wireless tower built in 1911 called for a structure capable of withstanding a wind load of 50 lb. per square foot of exposed surface. The tower is 26 ft. square at the base and 4 ft. square at the top. It is not clear what exposed surface is intended, whether that of two or of four columns and one, two or more sets of bracing. The working stresses specified are: 20,000 lb. per square inch for tension and 20,000 — $87l/r$ for compression.

The 300-ft. towers of the station at Key West, Fla., built in 1914, are of triangular cross-section. A wind pressure of 30 lb. per square foot tower surface is used. The working stresses are 18,000 lb. per square inch for tension and 18,000 — $70\,l/r$ for compression.

The specifications for the station at Guam required that the following, with other data, be inscribed on the name plate: "Wind, 30 pounds per square foot."

The first of a series of high-power radio stations was built at Arlington, Va., in 1912. When finished it was the largest and most powerful of the 48 stations of the Navy's coast system. The height of one of the towers is 600 ft., the base is 150 ft. square; the height of each of the other two towers is 450 ft. The arrangement of the towers is such as to support a triangular inclined aërial. A description by an officer of the Navy is given in the *Journal of the American Society of Naval Engineers* (Vol. XXV, 1913, p. 60), but nothing is said about wind loads. The Arlington station was followed by the Darien Station, A in Fig. 2, completed in 1915[2]. The three triangular towers are each 600 ft. high, with a spread of legs at the base of 150 ft. A wind pressure, normal to the direction of the wind, of 30 lb. per square foot of surface is assumed on the antenna and towers. The working stresses used for combined dead and wind loads are the same as those for the Key West station, cited above. Still more recent are the San Diego, Pearl Harbor and Cavite stations (B, Fig. 2), with towers of the same base and height as those of the Darien station. The design was modified from that of the latter, evidently to facilitate ease in erection.

The standard 820-ft. towers for the proposed station at Monroe, N. C., are triangular, with a spread at the base of 220 ft. The specifications call for a pull at the top of 22,000 lb. and wind on the tower equal to 30 lb. multiplied by 1½ times the exposed area of one face. The working stresses used are 16,000 lb. per square inch in tension and 18,000 — $70\,l/r$ in compression.

The Tuckerton, N. J., and the Sayville, L. I., stations, which came into such prominence at the beginning of the war, were built after German designs. The Sayville tower, sketched at C in Fig. 3, is 150 m. (492 ft.) high. The Tuckerton tower is 250 m. (820 ft.) high, but is of similar design. In both, the structure is of triangular cross-section and its bottom, brought almost to a point, rests upon an insulated ball and socket joint. The Tuckerton tower has a second joint 145 m. above the first; below this joint the triangular section is 5 m. (16.4 ft.) on a side, and above the joint 4 m. (13.1 ft.). The vertical element of the tower, on account of the joints, has only vertical rigidity, and is held in place laterally by 12 guys arranged in four groups of three each. It is to be regretted that the data and calculations of wind stresses for these towers are not available.

Radio towers, usually erected near the coast, are exposed to high wind velocities. According to the United States Government reduction formula, the actual wind velocities corresponding to recorded velocities of 110 and 100 miles per hour, respectively, are 82.9 and 76.1. Using these actual velocities in the wind-pressure formula $P = 0.004\ V^2$, the pressure for a recorded velocity of 100 miles per hour is 23 lb. per square foot, and for 110 miles it is 27.5 lb. The writer believes that with the assumption of 30 lb. per square foot, on 1½ times the exposed area of one face, working stresses of 18,000 lb. in tension and 18,000 — $70\,l/r$ in compression are permissible for all loadings. His preference, however, is for 30 lb. on 1¾ times the exposed area of one face and working stresses of 20,000 lb. per square inch in tension and 20,000 — $90\,l/r$ in compression.

Guy-Supported Radio Towers

Marconi towers are guyed masts or poles rather than towers. The 10 stations built by the J. G. White Engineering Corporation in 1914-15 comprise 79 masts ranging in height from 300 to 500 ft. The mast sections are built up of half- or quarter-cylinders made from steel plates. The diameter of a 300-ft. tower is 30 in. for the lower and 24 in. for the upper portion; of a 400-ft. tower, 42 in. for the lower and 30 in. for the upper portion. The steel tubes are stayed laterally by sets of guys at different elevations, four guys per set. In this design a wind pressure of 30 lb. per square foot of projected area was used.

The mast of a Marconi tower may be treated as a series of uniformly loaded beams supported at the guy bands. As in guyed stacks, the bending stress in pounds per square inch in any section is expressed by the equation $S = 0.106\,M/D^2t$, in which M is moment in foot-pounds, D diameter in feet, and t thickness of shell in inches. It is recommended that the maximum value of M (except for the upper section when it is a cantilever) be taken as $\frac{1}{8}\,pD(\frac{2}{3}\,h)^2$, in which p is the wind pressure per square foot of projected area and h is the distance in feet between supports (h is increased 20% to allow for unequal adjustment of guys).

For determining guy tension and compressive stresses, the methods used for guyed steel stacks need not be resorted to. An excellent treatment of the subject is given in a paper "Design and Construction of Guy-Supported Towers for Radio-Telegraphy," by Roy A. Weagant, published in *Proceedings of the Institute of Radio Engineers*, Vol. III, p. 135 (June, 1915), from which the following is quoted:

> Obviously, the vertical stresses acting on the tower are composed of those due to the weight of the tower itself, and those due to the vertical component of the tensions in the guys. We must, therefore, determine these latter as accurately as possible. Let us, therefore, consider the condition of affairs when the tower is erected, but when no wind pressure is acting. We see that the tower must be vertical, that the guys on opposite sides must be drawn up with equal tightness, and that they must be drawn up

[2] "Design of Darien Radio Towers," by C. A. Carlson, in *Engineering News*, Mar. 23, 1916, p. 546.

with sufficient tightness so that the tower and the guys will not move unduly when the wind pressure acts. Next suppose that the wind pressure is acting. Obviously, readjustments in the stresses in the guys take place. The windward sets have to sustain the full effect of the wind pressure. Therefore, on account of this added load they must stretch, and the tower will incline to leeward. It is also apparent that, to avoid weakening the tower, it must maintain a straight line. In order that this condition may be realized, it is necessary that each windward guy span must increase an amount proportionate to the movement of its point of attachment, which condition can only be realized when each set of guys is stressed initially to a definite amount. When a guy is stretched between two points, it forms the curve known as the catenary, and the tensile stress produced is given by the following equation . . .

The reader is referred to the paper for the method of calculation, which is rather involved. The author gives the numerical calculations and design of a mast 625 ft. high, 3 ft. in diameter, stayed by six sets of four guys each. Wind pressures are assumed as 15 lb. per square foot of projected area for the first 100 ft. from the ground, 16 lb. for the next 100 ft., 21 lb. for the third 100 ft., and 25 lb. for the remaining portion. If the pressures at any time are differently distributed, the computed adjustment of guy stresses will not be realized and the vertical member will be subjected to bending in addition to that expressed by the formula given two paragraphs above.

Towers for High-Tension Transmission Lines

The first high-tension line for the transmission of power in which steel towers were used exclusively was a line in Mexico 101 miles long built in 1903. Since that time such lines have been built by the score and towers by the thousand.

The lateral wind pressure on transmission lines has been much discussed. Well known engineers have arrived at widely different conclusions. The author of the article on electrical power transmission in the "Encyclopedia Britannica" writes, "the actual possibility of wind pressure is very generally overestimated, and has resulted in much needlessly costly construction." But another writer (Joseph Mayer, in *Engineering News* of Jan. 4, 1906, p. 2) says, "such lines should, therefore, be built strong enough to resist not only the commonly occurring, but also the exceptionally violent local storms."

Many experiments have been made during late years in the interest of aëronautics on the resistance of wires to air currents. Those made in the English National Physical Laboratory[3] seem to show that in the fundamental equation for force, F, per unit of length, $F = kDV^2$, k is not a constant but a function of the product of the diameter, D, of the wire and of the velocity, V, of the wind. According to Loenig, "Military Aëroplanes," for smooth wires $k = 0.0026$. The writer assumes for transmission line wires $k = 0.0025$.

Wires in sleet regions are sometimes coated with ice, and the question arises whether provision should be made for heavy winds occurring at the same time.

Basing on a considerable amount of data, the writer recommends that the following wind pressures be assumed:[4] (1) On the tower itself, 30 lb. per square foot on 1½ times the exposed surface of one face; (2) on bare wires 15 lb. per square foot projected area; (3) on ice-covered wires, up to ½-in. radial thickness of ice, 10 lb. per square foot; (4) on ice-covered wires with more than ½-in. ice, 8 lb. per square foot.[5]

In the "flexible" type of tower the assumed wind pressure controls the design. In the more common "windmill" and kindred types, the assumed pull on the wires from unbalanced loading largely determines the design. This pull acts longitudinally with the line while the main force of the wind acts transversely to the line, but it is common practice to make all sides of the tower alike.

Assumed working stresses are as important as assumed loadings. Here again there is wide variation in practice. It might be well to divide proposed towers into three classes, A, B and C, and to assume working stresses in accordance with the classification, thus:

Class A—Towers for a line whose customers insist upon uninterrupted service and penalty clauses, and towers where failure would mean danger to life and property, as in thickly populated regions: 20,000 lb. per square inch in tension and $20{,}000 - 90\,l/r$ in compression.

Class B—Towers for a line where interruptions under certain limitations are permissible, through sparsely settled country: 24,000 lb. per square inch in tension and $24{,}000 - 100\,l/r$ in compression.

Class C—Towers where cost is the primary feature to be considered and the question becomes, What are the least requirements which will enable the line to do its work?: 30,000 lb. per square inch in tension and $30{,}000 - 120\,l/r$ in compression.

At present the majority of towers are of Class C. The engineer often finds it a commercial impossibility to have towers built as he would like to design them. The situation is similar to that of highway bridges forty years ago; and just as the bridges of that day would not be tolerated now, many towers of today will not be tolerated a generation or two hence.

Headframes

A mine headframe, the structure over a shaft which supports the hoisting gear and the like, is a tower and will be treated as such.

Ketchum, in a paper on "Design of Mine Structures," specifies for wind loads on headframes:

> Where the headframe or tipple is inclosed, the wind load shall be assumed at 30 lb. per square foot of exposed surface acting horizontally. Where the framework is open the wind load shall be taken at 50 lb. per square foot acting on the projection of the members of the headframe or tipple. In calculating the stresses due to wind, the wind loads may be assumed as applied at the joints of the structure. Where one side of the structure is open so that a deep cut or pocket is formed the wind load shall be taken as not less than 60 lb. per square foot on the projection of the cup-like surface.

For wind-load stresses his specifications read:

> The allowable unit stresses when the wind-load stress is combined with the dead-load stress plus twice the working-load and machinery-load stresses shall not exceed the allowable unit stresses for dead loads by more than 25%. If the sum of the wind-load unit stress, the dead-load unit stress, and twice the working-load and machinery-load unit stresses

[3] "Technical Report," of the Advisory Committee for Aeronautics for the year 1912-13, p. 126.

[4] The recommendations following are taken mainly from a paper by the writer, "Structural Steel Poles and Towers," reprinted in *Engineering News* of Nov. 28, 1912, p. 988.
See also Thomson, "High Tension Transmission Lines, Poles and Towers," *Transactions*, Can. Soc. C. E. Vol. XXX (1916) p. 459.

[5] In the south ¼ to ½ in. of ice coating is sufficient, but in northern countries like Canada more allowance must be made. The Montreal Light, Heat & Power Co. assumes ¾ in. on each side, making the diameter of the cable 1½ in. plus its own thickness.—Thomson.

exceed the allowable unit stress for dead loads by more than 25%, the area of the section shall be increased to reduce the actual stresses to within the prescribed limit. Wind-load stresses need not be combined with breaking-load stresses.

While the stresses specified are conservative, the load of 50 lb. seems excessive, even for headframes in locations subject to high winds. Specifications of some coal companies call for a wind pressure of 40 lb. The writer has designed a number of headframes using a wind pressure of 30 lb. on 1½ times the exposed area of one face. He does not hesitate to use 25 lb. per square foot of exposed surface if the structure is inclosed. For a cup-shaped section the pressure is uncertain, but 60 lb. is well on the side of safety.

The stresses in headframes other than those of the A-type are usually statically indeterminate, but for wind stresses it is seldom necessary to resort to other than approximate methods. In a headframe with longitudinal bents of two posts and back brace, they may be determined by considering the back brace redundant and the tower portion as transmitting all wind loads to the ground; or, the tower portion may be considered as a lattice girder supported at the top and bottom with the reaction at the top carried to the ground by the back brace. In a headframe with transverse bents of three posts the middle post may be considered redundant and wind stresses carried by the outer posts and bracing between them.

Machines Take the Place of Men on 20-Mile Concrete Road

Grading, Subgrading and Slab Construction Are Machine Operations on Lincoln Highway From DeKalb to Geneva, Illinois

TWIN outfits of grading machines, mixers and tampers are putting in 18-ft. slab at the rate of 900 ft. a day on the Lincoln Highway between DeKalb and Geneva, Ill. Both outfits operate from a single loading plant and track system which are to be set up three times for the 20-mile stretch of road. All processes are mechanical, from loading the cars and making the grade ready to placing the concrete slab. Except trackmen and a few shovelers to clean up after the grading machines, to spade behind the mixer and to cover and dike the completed slab for ponding, the workmen are machine attendants. A complete car-camp outfit houses and boards the working force.

The operation comprises 20½ miles of 18-ft. concrete road to be constructed according to the specifications of the Division of Highways of Illinois. Grading runs about 3000 cu. yd. a mile, with cuts seldom over 1½ ft., all on old gravel-surface road. There are four towns of size, all with railway connections, on the section, but the bulk of the work is not close enough to any town to make it a convenient place for housing the working forces, nor did any have the facilities free for handling the contractor's shipments. This determined the location of the loading plants outside the towns at strategical points with respect to the operations.

Dividing the road into four-mile sections, as indicated by Fig. 1, the loading plant with its track system will be set up successively at the points marked by the Roman numerals. One concreting and grading outfit starts at A and the other at B, both working in the

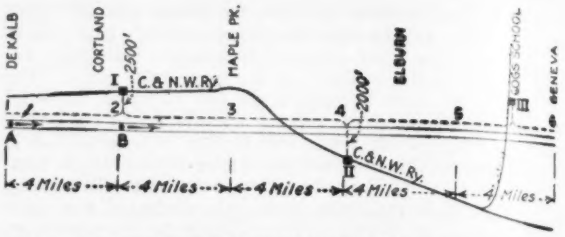


FIG. 1. SUCCESSIVE POSITIONS OF LOADING-PLANT AND SERVICE-TRACK SYSTEM

same direction. When A reaches point 2, B will have reached point 3. Then the loading outfit will be shifted to II and outfit A will be shifted from point 2 to point 4, when it will proceed to point 5, while B outfit continues from point 3 to point 4. The shift to set up III will be conducted in the same manner, except that from here each outfit will have a two-mile section to build.

At each set-up of the loading plant the track arrangement and procedure are as indicated by the diagram, Fig. 2. There are five miles of 2-ft.-gage track

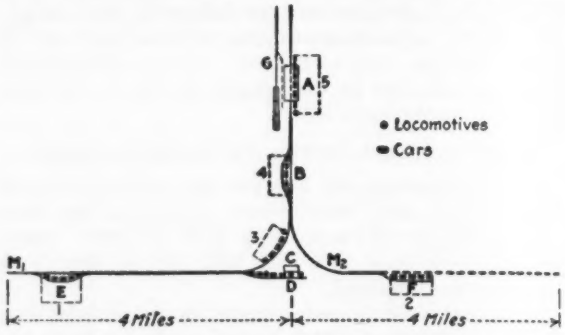


FIG. 2. SERVICE-TRACK DIAGRAM OF OPERATING PROCEDURE

made up in 15-ft. sections of 25-lb. rail and seven steel ties to a section. At A are the loading bins to which materials are brought on the switch G, on the extension of which stand the camp cars. At B, E, D and F are industrial-track sidings, and at C is the blacksmith shop. One outfit M1 starts at the end of the eight-mile section to which the industrial track is carried. The other outfit M2 starts near the center of the eight-mile section. As M1 moves ahead the track is taken up from behind, carried forward on cars, and put down ahead of M2. When the eight-mile section is completed there is, as stated previously, another set-up of the loading plant.

Essentially, the loading plant is a three-compartment bin, A, straddling the industrial track, a siding for material cars, and a crane track, with two locomotive cranes. The cranes unload from cars into the bins with clamshell buckets or, in case of gravel or sand, when the bins are full, into stock piles from which, when cars are not in, the material is rehandled into the bins. Rectangular flat-bottomed bins are employed, one for each material, but all forming one continuous structure. They discharge to batch-boxes on cars through vertical chutes so spaced that a number of cars receive their charges simultaneously. The bin construction and the details of car loading, particularly in the apparatus and procedure for handling cement in bulk, received careful consideration.

Rectangular flat-bottomed bins were chosen instead

of hopper-bottom bins because they cost less to build and could be built, knocked down and rebuilt more quickly. The fact that material pyramided itself on the flat bottom between chutes and remained in dead storage was, in comparison, considered to present no great disadvantage, for when the time came to empty the bins finally a few men with shovels could quickly remove the remaining material into the chutes. In fact, the dead storage was held to be an advantage on occasion. When materials' deliveries—and, more particularly, cement shipments—fail at a critical stage of the work and only a little more material is needed to carry the work beyond this stage, the dead-storage reserve will often save the situation from disaster.

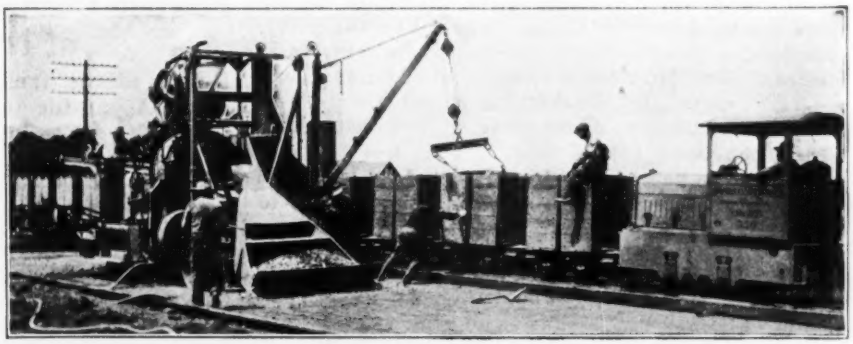


FIG. 5. CARS DRAWN BY GASOLINE LOCOMOTIVES DELIVERING TWO FOUR-BAG BATCHES EACH

Bulk cement is received in flat-bottom gondola cars and is unloaded into the open-top bin by a locomotive crane with a clamshell bucket. Tarpaulin covers for cars and bin protect their contents from rain. Chute construction and operation present the only unusual features. The chutes are vertical, sheet-steel boxes 15

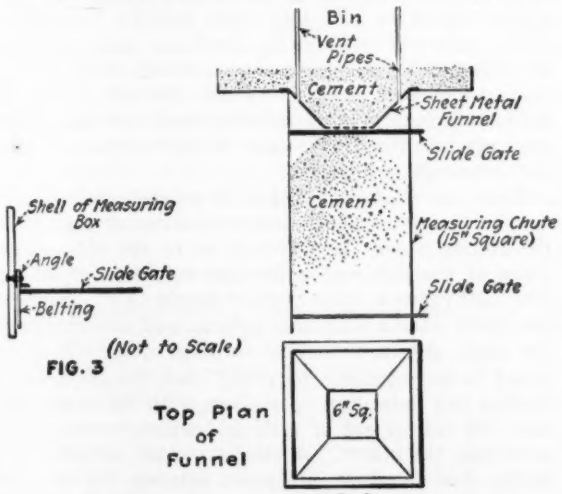


FIG. 3

Top Plan of Funnel

FIG. 4

FIG. 3. LEAKAGE OF BOTTOM-CHUTE GATE ELIMINATED BY BELT PACKING; FIG. 4. FUNNEL IN TOP OF CEMENT CHUTE FACILITATES CLOSING TOP GATE

in. square inside and of 4 cu.ft. capacity between top and bottom horizontal slide gates. Dusting at the joints, leakage at the bottom gate, and difficulty in closing the top gate through the column of cement, caused trouble at the start. Dusting was eliminated by painting the joints with cement paint. Leakage between the closing edge of the bottom gate and the side of the chute was remedied by the arrangement shown by the sketch Fig. 3. The strip of belting suspended as shown formed a cement-tight packing for the gate to close against. To facilitate closing the top gate, a sheet-iron funnel, as shown by the sketch Fig. 4, was set into the top of each chute. This reduced, to small dimensions, the column of cement which had to be cut through in closing the gate, and made the closing easy. The vent pipes extending to the top of the bin prevent any trouble arising from compression of the air in the angular space between the funnel and the chute sides.

Scheduled train service maintains coördination between the loading plant and the twin subgrading and paving outfits. With 100 cars and five locomotives, five 20-car trains are so operated that there is always one train taking load at the bins, two trains en route to the mixers and two trains at the mixers being unloaded. Each car carries two batch-boxes, each holding four-bag batch. Fig. 5 shows train equipment.

The boxes are charged first with sand to mark, then with the measured chute of cement, and last to the top with gravel. Since the boxes are bottom-dump, this sequence of sand, cement and gravel is a little objectionable at the mixer because the sand sticks and the charging skip does not always clear itself readily. This objection is considered to be overbalanced by advantages in handling the cement. Were the stone put in first, which would be preferable in charging the mixer, the cement would shake down into the voids to an objectionable degree. The more important disadvantage, however, is considered to be the seepage from wet sand which, if the sand were on top, would be down through the cement. This, in case of any delay in handling the boxes, might start the cement to set and endanger the quality of the mix. Since stone seldom contains free water to any amount, there is little danger of seepage into the cement when the stone is loaded last, and the water in the sand underneath the cement sinks to the bottom of the box, where it causes no trouble.

When the trains are laid up for the night they stand as indicated by the diagram Fig. 2, in which the circles represent locomotives and the rectangles represent cars. At quitting time train 5 is run under the loading bins; train 4 is laid up in siding B and its locomotive run to siding D; train 3 with its locomotive stands on the main line; train 2 lays up 18 cars in siding F and the locomotive with two cars takes the men on outfit M2 to camp and runs to siding D; train 1 lays up 18 cars at siding E and the locomotive with two cars takes the men of outfit M1 to camp and then goes to siding D. With this arrangement train 3 has a free main line for track shifting or other night work and is ready to run in and take the place of train 5 in the morning. Two locomotives with two cars each are ready to take out the two construction crews and connect up with their trains at E and F. The other locomotive on siding D connects up with train 4, and the day schedule goes into operation.

At the mixers the batch boxes are picked off the cars one at a time by a crane mounted on the mixer, are dumped into the charging skip, and are returned to the car. The mixer has the regulation elevating charging skip, except that the rear end of the skip is closed instead of being open as for charging by wheelbarrows. The batch boxes are of wood, 2 x 3½ x 4 ft., with single-bottom flap doors controlled by a hand latch, and two side irons, with eye-holes for the crane yoke to hook into.

Sequence of Operations

On beginning work (Set-up I, Fig. 1), the grading outfit was started early enough to complete the work ahead of and between mixers M1 and M2, Fig. 2. Thereafter the grading has been kept about three miles ahead of the mixers. The grading outfit consists of an elevating grader hauled by 12 horses and loading into dump wagons which take the material to the shoulders; a scarifier to root up parts of the old gravel road too hard for easy elevating grader excavation; drag scrapers for miscellaneous operations, and a portable camping outfit for men and teams. The camp is moved two miles at a shift, the gang working one mile each way from camp.

The two subgrading and paving outfits are duplicates, and each consists of a 10-ton roller, a blade scraper, a subgrader, a paving mixer and a tamping and finishing machine, besides canvas, steel side forms and the usual small tools. The procedure is the same with both outfits. The roller hitches onto the blade grader, which shapes the grade and ditches close to cross-section. The grade is then rolled down and the steel side forms are set. The subgrade finishing machine rides on wheels on the side forms, and, hauled by the roller, planes the grade down to exact form and elevation. Finally, the subgrade is finished by rolling. All grading operations are machine operations except setting the forms and cleaning up with shovels behind the subgrader.

At the mixer the operations are of the usual order except that the slab is compacted and finished by machine tamping and belting. The paver is a four-bag batch mixer on caterpillar tractions and with boom-and-bucket distribution. The concreting crew consists of two men handling the batch-boxes, one on the crane, one operator, one dump man, two spaders, one operator on the tamping and finishing machine, and two men covering the slab with canvas, building dikes and ponding. When the slab has cured, the earth covering will be removed direct to the shoulders by blade scrapers. About 350 ft. of finished slab has been the output for each outfit with the crews being organized; 450 ft. a day is expected when the crews have settled down and all operations are coördinated.

Contrary to road work, usually, the workmen are housed and boarded in construction camps. At the unloading plant the camp consists of an office car, a kitchen car and a mess car and several bunk tents. This camp provides for the concreting, subgrading, unloading plant and train crews. For each grading crew there are a kitchen and mess wagon and a bunk tent, which are moved along with the crew, as previously stated.

The contractor is James O. Heyworth, Chicago, Ill., whose superintendent in charge of the work is R. H. Anderson.

English Channel Train Ferry Bridge of 120-Foot Span

Details of the Trusses, Lifting Tower, Operating Apparatus and Mooring Provisions—Special Design Features

By P. J. Risdon
Hove, Sussex, England

DETAILS of the train ferry bridges constructed during the war in connection with the train ferry between England and France instituted in 1918 contain several special features. These bridges vary in length from 80 to 120 ft., according to the range of tide to be provided for at the different ports of call. They are of the half-through type, like the 120-ft. span here described and illustrated. The especially noteworthy design details include the pin-connected intermediate floor-beams and transverse bracing to allow accommodation to any list of the boats, and the lifting and mooring details at the outer end, including the "elephant-foot" bearing and the mooring pin.

The train ferry between England and France instituted in 1918 comprised four services, namely, Richborough to Dunkirk, 54 miles; Richborough to Calais, 35 miles; Southampton to Dieppe, 130 miles; and Southampton to Cherbourg, 91 miles, one boat being assigned to each service. Each boat provided accommodation for 54 fully loaded, four-wheel railway wagons or motor lorries, or as many bogie vehicles, locomotives, heavy guns and tanks as the available space permitted, the effective length of tracks on board being 1080 ft. The cost of each boat was about $950,000. Upon the main deck four parallel railroad tracks are laid, which converge into two tracks near the stern, where switches and crossings are placed.

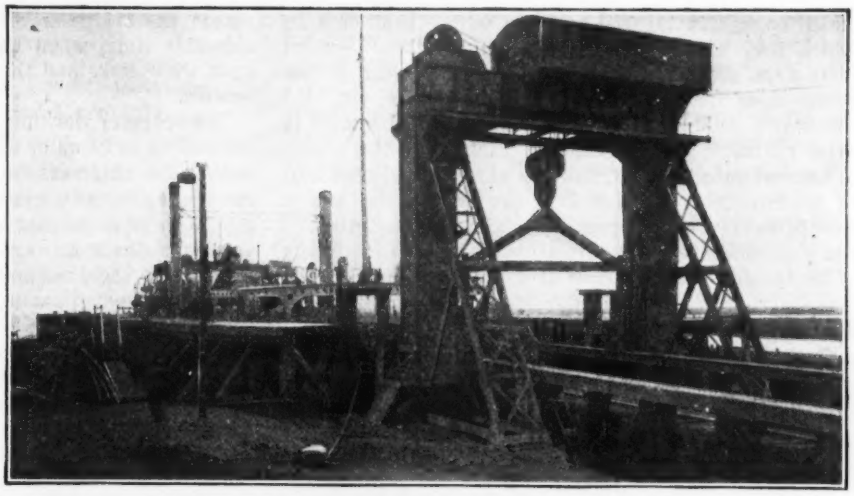
Each port was equipped with special landing facilities, to insure a smooth and uninterrupted passage for the rolling stock from the shore to the ship at any stage of the tide and under any condition of loading. The tidal range in some cases is nearly 14 ft.; moreover, the draft varies with the amount and distribution of the load. Again, a list occurs when either side of the vessel is more heavily weighted than the other during loading and unloading operations, with the consequence that one rail or set of rails is frequently at a higher level than the others. A steel structure, or train-ferry bridge was therefore interposed between the shore and the boat, the general arrangement and details of which are illustrated.

The bridge is of the half-through type, as stated above, and consists of two main trusses with cross-girders or floor-beams spaced 10 ft. apart and hung upon pins from the main vertical web members. These single-pin connections of the floor-beams to the main truss verticals permit of the bridge accommodating itself at the outer end to any list of the boat during loading operations. While providing for this, an extra allowance was made against an extraordinary list due to possible damage as the result of collision or of submarine attack.

Horizontal bracing, consisting of plates and angles, is provided at the level of the top of these intermediate floor-beams. This bracing constitutes a horizontal stiffening girder, of which the two outer longitudinal stringers form the flanges, thus avoiding direct con-

nections of this horizontal bracing to the main trusses, which would have impeded the freedom of vertical motion of the latter relatively to each other. The lower chords are connected together at 20-ft. intervals by transverse struts with single pin connections, and a light horizontal system of bracing.

From the foregoing description it will be seen that, instead of rigidly connecting the cross-girders to main girders and providing a separate hinged flap or apron between the end of the bridge and the boat to allow for list, the bridge as a whole accommodates itself to such a list as well as to tidal variations. Thus, with a list to, say, 1 in 24, the horizontal plane passing through each rail level on shore is gradually converted into an inclined plane (transversely) of 1 in 24 at the boat end, the winding of the plane being so gradual as to be imperceptible under working conditions. The maximum vertical relative movement provided for at the boat bearings of the bridge is 24 in. either way before anything fouls.

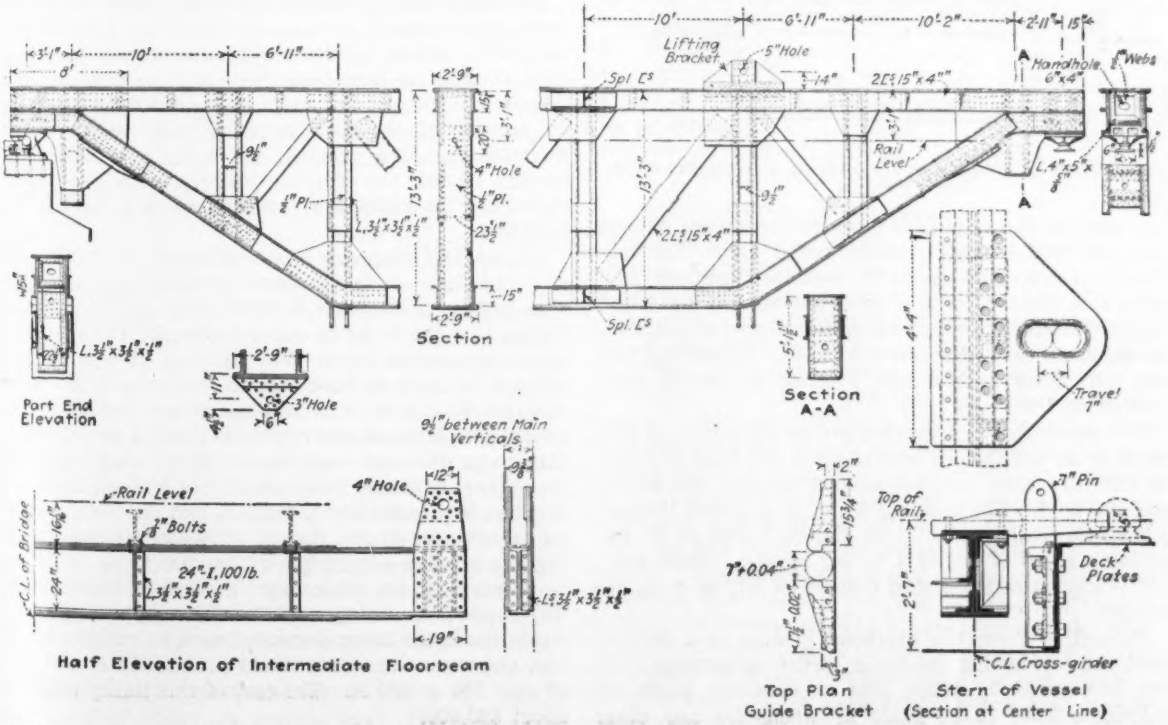


FERRY BRIDGE, OPERATING TOWER AND CHANNEL BOAT MOORED IN PLACE

At the boat end each main girder is fitted with a bearing of cup-and-ball type to insure a flat bearing on the deck of the boat at any variation from a horizontal plane under working conditions. This bearing is known as the "elephant foot."

At a distance of 21 ft. 3 in. from the boat end of the brigde, and outside the main trusses, a pair of box columns built upon masonry piers support transverse overhead girders which in turn carry the machinery house and hoisting gear. The hoisting frame, spanning the ferry bridge transversely, consists of a triangular truss, from the ends of which depend the vertical tension links upon which the main trusses hang. To the apex of the lifting frame the sheave pulleys for the steel wire lifting wire ropes are secured. Each joint between the sheave pulleys and the connections to the main girders is made by a single pin to permit of free longitudinal, transverse and vertical movement. The ends of the lifting frames are fitted with hardwood rubbing blocks working in vertical guides against rubbing strips on the inner faces of the two towers.

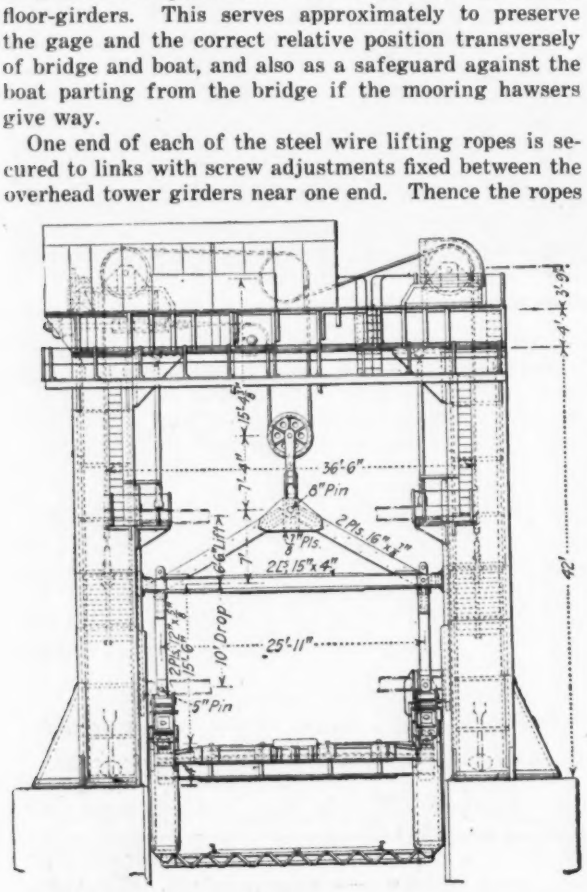
Continuous rail connections are provided by means of special rail flaps, hinged to the end cross-girder,



END PANELS OF 120-FOOT TRUSSES—DETAILS OF FLOOR-BEAMS, PIVOT PIN AND "ELEPHANT-FOOT" BEARING

which engage in tapered seatings on the boat deck in which they are free to slide longitudinally. Hinged plate flaps are also provided for the full width of the bridge floor for the passage of motor lorries, etc. On the boat a solid steel mooring pin of 7-in. diameter is fitted centrally between the two tracks. As the bridge is lowered onto the boat, this pin engages a slotted hole in a cast-steel plate bolted to the end of the bridge floor-girders. This serves approximately to preserve the gage and the correct relative position transversely of bridge and boat, and also as a safeguard against the boat parting from the bridge if the mooring hawsers give way.

One end of each of the steel wire lifting ropes is secured to links with screw adjustments fixed between the overhead tower girders near one end. Thence the ropes



END VIEW OF TOWER—SUPPORTING AND OPERATING DETAILS

pass around jockey pulleys down to the sheave pulleys, up again to the winding drum, round which they take 2 to 2¼ turns, and thence in opposite directions over pulleys at the tops of the tower columns, below which they are secured to counterbalance weights which work up and down inside the tower columns. Equalizing bars are introduced in the rope systems to insure equal tension on the ropes.

The counterbalance weights are so proportioned that there is an unbalanced weight upon the boat of about 10 tons to insure constant contact between the bridge and the boat. The winding drum is actuated through a reduction in gearing by an electric motor of 30 hp., giving a speed of lift of 4 ft. per minute. Hand gearing is also provided giving a speed of lift of 4 in. per minute.

Depending from the overhead girders is a pair of steel links to which the main girder suspension links can be secured by single pins on occasions when adjustments have to be made or when, for any other reason, the bridge may be out of commission for a considerable time, when the bridge may be hung direct upon these links and the ropes therefore be relieved of tension.

The ordinary working limits of gradients are: Longitudinally 1 in 24 up or down; transversely 1 in 35 either way. The shipment of locomotives, tanks and heavy guns is, as far as urgency permits, carried out at about mean tide so as to pass across the bridge approximately on a level track and avoid injury to rolling stock with long fixed wheel-base and heavy axle loads, which injury might occur when passing from a level track to a gradient of 1 in 24.

The erection of the bridges was a comparatively simple matter. In some cases they were floated into position on pontoon barges, in others they were built in position at a higher level than their working positions and were then lowered into their final positions, the outer end being suspended from the winding drum, and the shore end being lowered, in stages, by means of hydraulic jacks, in the usual manner.

The official record time for the complete cycle of the unloading and loading operations is 19 min., but under specially urgent conditions it has actually been done in 10 min. When it is considered that to discharge such a cargo and load up another by means of cranes occupies a matter of days, the saving of time effected by the train-ferry service can be better appreciated. In addition there is the saving of time, labor and expense otherwise involved in partially dismantling rolling stock for shipment and reërecting it upon arrival at destination. The 120-ft. span weighs 200 tons, and the 80-ft. and 100-ft. in proportion. The writer was the designer of these bridges.

To Reline Herron Hill Reservoir

Leakage from the Herron Hill reservoir of the Pittsburgh water-supply is to be eliminated by relining the reservoir. Money for the work was recently appropriated through a bond-issue vote of the people. The reservoir is part of the city's high-service system, and, on account of the high pumping cost, added to the filtration cost, the value of the water now wasted in leakage exceeds the carrying charges for a new lining sufficiently to make the proposed work a paying investment.

Herron Hill reservoir is a small basin, of 12,000,000-gal. capacity. It leaks about 1,000,000 gal. per day. The bottom is at present lined with an old concrete lining, thought to be of natural cement; the sides are paved with stone block. For relining, it was at first planned to apply to both bottom and sides a two-layer concrete lining with a waterproofing membrane between, each layer of concrete to be about 4 in. thick. On this basis the cost was estimated at about $90,000. Since then, however, the possibility of a single-layer lining has been considered, and Charles A. Finley, managing engineer of the Bureau of Water, is now studying the relative advantages of the two types of lining, in preparation for beginning the work of construction. The single-layer lining would be shot onto a reinforcing mesh, the latter being depended upon to prevent cracking, and expansion joints would be required at intervals of only 200 or 300 ft. The cost of this lining would be about $60,000.

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HARMON V. SWART
Contract Bond and Insurance Broker, New York City

CURRENT practice in the contract-bond business forms the subject of a communication recently received by this journal. The writer deals with such features as rates charged by surety companies, relations of owner, bonding company and contractor, a contractor's financial status, credit and payments on defaulted contracts. He also criticizes certain details of the business. In order to have these points answered, *Engineering News-Record* requested Harmon V. Swart, of New York City, a specialist in contract bonds and insurance, to reply to the questions asked and explain such points as seemed to demand further elucidation. In the matter which follows paragraphs from our correspondent's letter are printed in italics, while Mr. Swart's replies are in ordinary Roman type.

The uniform charge of bonding companies has been one-half of one per cent. per annum on total of contract sum. This work applies on all municipal work generally and, to a man up a tree, my opinion is that the bonding companies have been instrumental in promoting legislation in the various states to this effect.

The standard rate of all surety companies to all contractors is 1½ per cent. on the total amount of the contract. This rate has been in effect since November, 1917, and covers the total charge in all cases except where the work of construction carries over a period in excess of two years. In this event there is an additional charge after the second year. As far as I know, the opinion expressed—that bonding companies have been instrumental in promoting legislation relative to rates—is entirely without foundation in fact, for it is a generally understood fact that the rates are in no way fixed by legislation.

The bond is not reduced as the work is partially completed, but continues on the full amount of contract until work is completed.

With the exception of bonds covering work done for certain New York City departments and a possible few other isolated cases, this is true, but, however, the bonding company is in no way responsible for this general arrangement, as it is entirely beyond its power to reduce the amount of the bond as the work progresses. That is the option of the owner. In view of the fact that the face value of all bonds is determined by the owner, if the owner on a long-time contract would be willing to reduce the bond each year in proportion to the completed work and grant a final acceptance on the completed work, the bonding company would be perfectly willing to reduce the amount in the same proportion. Apparently it is through slight misunderstandings of the nature just referred to that unmerited criticism of the bonding companies has been promulgated.

The rate or risk assumed takes no account of the contractor's ability, organization, good financial standing, plant and record for making good on his obligation. So that the strong contractor has to carry the "lame ducks." As to bonds on private work, the same rate and statements above apply, except, of course, that the providing of a bond is a matter of agreement and not fixed by statute as in municipal or public work.

It is simply a matter of fairness that makes the rate on contract bonds the same to all contractors. In justice it could not possibly be otherwise. To begin with, no contractor, regardless of his financial standing, ability, plant or past record, is able to secure a contract bond until he is of his own ability, or with sufficient responsible indorsement, able to meet the qualifications of a bonding company. This done, nothing else matters.

Let me illustrate the point still further by comparing it with the borrowing of money at a bank, for the two transactions, as far as responsibility goes, are analogous: John Jones wants to borrow $10,000 at the bank. Now, John Jones' financial responsibility is not very great, but his character, his past record, his business ability and personal acquaintance with the bank satisfies the banker that he is worthy of a credit extension of this amount, and he is granted the loan at the standard rate of interest, 6%—as a matter of fact, such a thought as charging him in excess of the standard rate would never enter the banker's mind.

The following day Charles Adams asks a loan of a like amount, $10,000. His character, past record and business ability are not a bit better than those of John Jones, but his financial responsibility is probably ten times greater than that of Mr. Jones. Does he get a lower rate of interest than the standard, 6%? Most assuredly not. The rate of interest is so generally accepted that it is rarely ever asked or questioned. The whole transaction hinges on whether or not the borrower can satisfy the bank that he is worthy of the loan.

Still another case: Henry Brown asks a loan of the same amount, $10,000. His business record is fair; he is thoroughly honest; his financial responsibility is low, and, generally speaking, the bank does not consider him worthy of the loan without an indorser. He secures the indorsement of a responsible person, who has faith in him, and the bank accepts this indorsement and grants the loan. Does he pay a higher rate of interest because he is less responsible? Not at all. He has met the requirements of the bank in furnishing a responsible indorsement, and the loan is granted without further question, at the standard rate of interest.

SURETY COMPANY'S POSITION LIKE BANKER'S

The position of the surety company is precisely the same as that of the banker. The surety company obligates itself to pay up to the face value of the bond in the event that the contractor does not make good. And in the event that the contractor is, in its eyes, not strong enough to secure a bond on his own responsibility, he is, as in the case of Henry Brown, requested to get an indorser. Thus you will see it is palpably unjust for anyone to criticise the action of a bonding company in granting a bond to any contractor, for no outsider is in a position to understand what requirements have been met before the bond was issued.

Let us look at it from another angle for just a moment. The general practice of most bankers in loaning money is to loan up to about one-third of the net worth of the borrower, while in many cases surety companies, in underwriting a contractor, will issue a bond, the amount of which is many times the net worth of the contractor. It is thus very obvious that the assumed risk is proportionately greater.

Entirely aside from the justice of the proposition, any discrimination shown by a bonding company in rates would lay it liable to forfeiture of its charter authorizing it to transact business, for violation of the antidiscrimination law as applied to insurance.

Frequently a contractor would prefer to put up good securities for faithful execution of contract, but cannot do so under law on municipal work.

On a recent job the contractor deposited securities with the railroad company and saved over $25,000 which a railroad bond would have cost. The railroad company was in far better position to proceed in case of default as it had quick assets available instead of a possible or probable suit to force a bonding company to get under promptly and meet its obligation under the bond.

Personally, I know of no law preventing a contractor putting up securities in lieu of a surety bond. It sometimes is done, but nearly every contractor who does it says, "never again." I think I am entirely familiar with the $25,000 case mentioned above; if it is the one I have in mind, it is a percentage contract and, therefore, the contractor is fairly safe in putting up securities in lieu of a bond. If this is not the same case, I am familiar with one very similar, and I know something of the way the costs have gone up since the work started in October, 1917. Consider for a moment how the contractor would feel over having several hundred thousand dollars of his liquid assets tied up on the other side of a losing contract, as it would be were it a lump-sum instead of a percentage contract.

Contractor's Assets Tied Up Through Suit

Frequently, as we all know, there arises a legitimate difference of opinion, which occasionally must go to the courts for adjudication, and not infrequently considerable time has elapsed before a decision is rendered. In such case the contractor finds it extremely embarrassing to have a legal fight on his hands with a large amount of his liquid assets in the hands of his opponent. As a plain matter of fact, while I say there is no law preventing a contractor putting up securities in lieu of a surety bond, I have yet to find one thing in its favor.

While the putting up of securities tied up contractors' assets, it showed the strongest kind of good faith to the railroad company and creditors to make good, and if you have found a bonding company that did not tie up the assets of the contractor when giving a bond you have knowledge that I do not possess.

Yes, I must confess you are right when you say that, if this were the case, I have information that you do not possess, and I am glad indeed of the opportunity to pass it on to you. With rare exceptions—and the exceptions are so rare that they are really negligible—the surety company does *not* tie up the assets of the contractor when writing a bond. The contractor is asked to make a complete financial statement to the surety company, solely that the latter may form an opinion of the contractor's financial ability. Occasionally a contractor may be a little light financially and offer the indemnity of a third person, who is financially responsible. This corresponds to an indorser of a note already referred to in my illustration of "Henry Brown."

Almost never, however, are the assets tied up. The contractor and the indemnitor, should there be one, may do as they please with all of their property, and the surety company's hands are absolutely tied. It has formed its own opinions and is backing its own judgment by writing the bond for which it exacts the standard rate, and once this contract bond is signed, sealed and delivered, it is beyond the power of the surety company to recall or cancel it, and it is then bound until the contract is completed and it is released by the owner from all liability under the bond.

I have discussed these matters on two occasions with representatives of bonding companies, and the answer has been the rate of ½ per cent. per annum on total amount of contract for entire period has been found a fair average, but received no facts to substantiate the statement.

The history of the contract-bond business covering a period of the past 12 years furnishes the best possible answer to this statement.

Of the 10 companies writing contract bonds in 1908 but four still remain in business. Contract bonds are extremely hazardous even under the most favorable conditions.

No better justification of the present rates could possibly be given than the fact that several companies have tried to do business at lower rates than standard, and the majority of them were forced to close their doors; the remainder raised their rates and merged with older companies.

As the work progresses, the risk reduces and should be considered.

This was answered in a previous paragraph.

My feeling is that the general tendency is to get business and collect commissions with a different kind of ethics for assuming responsibility than we find in substantial, established businesses.

That this statement is in error there can be no doubt, and that the opinion was formerly solely through lack of information is equally clear to me. The trouble seems to be through the lack of publicity given in the great number of cases where payments are made on account of defaulted contract, the settlements of which are arranged to the mutual satisfaction of all parties

Three Parties to a Contract Bond

Do not overlook the fact that a contract bond is a three-party contract between the owner, the contractor and the surety company; that it is the contractor who gives his bond to the owner; that the surety company in return for its fee, based on a standard rate, certifies that the contractor is able to and will complete his contract, and for the fee just mentioned becomes the surety of the contractor in the amount of the bond, thus guaranteeing to pay this amount in the event of his default; that in the event of a default on the part of the contractor, or a dispute between the owner and the contractor, each has certain rights, under our law, which must be recognized by the surety company, and the surety company has no right or power to make any settlement with the owner that will in any way jeopardize the rights of the contractor under the law; that a contract imposes obligations on both the owner and the contractor, and the owner may not violate the contract without securing the consent of the contractor and the surety company, and later, still have the right to hold the contractor on his bond and his surety in the event that he, the contractor, violates his part of the contract.

Insurance of employees is covered by annual policies subject to renewal and cancellation on notice. Let a contractor meet with several losses of lives and you will find some of the companies much disposed to duck renewal.

This refers to workmen's compensation insurance. In the event that a contractor meets with numerous accidents, causing several losses of lives and the majority of investigations disclose the fact that most of the accidents were due to carelessness, his insurance company is entirely justified in declining to renew. The insurance companies are spending large amounts of money in accident-prevention work, and when an employer consistently disregards the recommendations made by his insurance company to put safeguards in his plant, I believe you will agree he is getting his just deserts when his company declines to renew his policy.

Many times refusal of the insurance company to renew is due to the contractor's having an incompetent broker—and, unfortunately, incompetent brokers are legion. Let me cite a definite case in point. A certain contractor secured a contract for $2,000,000. It was regarded as a particularly hazardous risk. For some time I had been handling this contractor's business, but in this particular case a friend influenced him to place the business with another broker who was representing one of the reliable companies, whose main office is outside of New York City.

Saving Effected in Cost of Insurance

Because the risk was so hazardous, the broker could get no policy issued at the branch office in New York and so used the long-distance telephone to talk it over with the home office. Still no satisfactory result, so he took his friend and together they went to the home office in New England. After an all-day session and considerable begging and pleading, the risk was accepted at an advance rate of 50%. The broker and his client both thought they were particularly fortunate in getting it accepted at all, so that, naturally enough, when I approached the man and told him I felt sure I could save him a tidy sum of money he was mighty skeptical about letting me attempt it, for fear the policy he had such a hard time to get would be cancelled forthwith.

Finally, he agreed to let me see what I could do. Very naturally I exercised great care in preparing my case prior to presenting it to the underwriter, and, when my data were all together I presented it personally from a viewpoint that I, as an engineer, thought would make the strongest appeal.

These are the results: I secured the policy at an annual premium of $30,000 as against $42,000 which he was paying for his old policy. Then, the second year I secured a further reduction of 40% or an additional $12,000 in the premium, making it cost him $18,000 per year instead of $42,000—a distinct saving effected of $24,000.

These notes have been prepared not necessarily with the idea that the surety company is always right, but rather to correct a few erroneous impressions which give birth to unjust criticism of a business that has made certain branches of big business safe at a minimum of expense—a business that through its fairness and equity has expanded and kept pace with its ever-growing requirements.

Status of the Engineer

THE following paragraphs are from the announcement of the state convention of engineers and architects to be held Oct. 14—15 in Columbus, Ohio, under the auspices of the Association of Ohio Technical Societies:

"No profession has done so little in the way of mutual helpfulness as technical men. We need an organization similar to that of the doctors and lawyers to place and hold our profession in its proper relative position before the public. This can undoubtedly best be done by reorganization of the Association of Ohio Technical Societies, providing for an executive board on which every member society shall be represented.

"Unionism is breaking into the ranks of the engineers. Already 40 unions have been formed by them. Is this the way to take care of our younger brothers? Unless we can provide other means for bringing the compensation of engineers to a reasonable parity with that of others, we must expect to see unionism increase rapidly, because men will not indefinitely see themselves left behind in the race for proper recognition of services rendered. This question deserves the attention of all technical men, and very careful deliberation should be given to it. We must look beyond the present, for hasty action based on present conditions may work immeasurable harm."

"The registration of engineers and architects is required by law in many states. It is a great question and affects every one of us. Whether we believe it or not, we will soon feel the effects of such legislation elsewhere and it is likely to come in Ohio at any time. Here, again, we need a strong organization to protect our interests, and, if desired by the majority, to propose and look after such laws as will assure satisfactory results."

Street Congestion in Pittsburgh

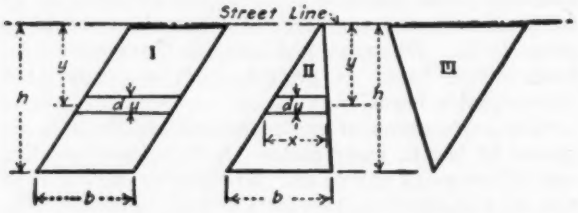
Abnormal traffic congestion in the streets of the central business district constitutes the most important problem of municipal planning in Pittsburgh, according to N. S. Sprague, chief engineer of the city's Department of Public Works. It has been estimated that 280,000 persons enter the downtown district each day, and of these, according to figures of E. K. Morse, transit commissioner, no less than 165,000 are brought in by street cars. As the thoroughfares are narrow and the blocks rather long, both vehicle and pedestrian traffic is remarkably dense at the morning, noon, and evening travel hours. This situation controlled the city authorities in devising the street-car loop subway which was authorized by bond-issue vote of the people two months ago. Rapid transit is considered to be only a secondary necessity, as the extreme time of travel between home and city with present facilities does not much exceed 45 min. and there is not likely to be urgent need for rapid transit until a travel time of one hour is reached. The authorities believe that with the clearing of the street cars from the entire business district, by means of the street-car subway, the street congestion will be sufficiently relieved to make it possible to postpone for another decade or two other means of relief. The removal of street cars from the surface is therefore planned to be permanent, and the full capacity of the streets within the business district will be made available for vehicle and pedestrian traffic.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Computation of Paving Assessments

Sir—Upon returning from overseas, I found an article in *Engineering News-Record* of May 30, 1918, p. 1049, by George H. Ruhling, on paving assessments. Some time before entering the service I made similar studies on this subject, but used different fundamental equations to get the rate of assessment varying from the street line. The equations used were of the form R equals y^n, where R is the total of assessment "units" on a 1-ft. strip perpendicular to the street line, at any depth of strip y. Equations of this sort give equitable results and, at the same time, allow the use of existing tables. My results as tabulated were theoretically correct for both triangular and rectangular shaped lots,



FUNDAMENTAL FORMS OF THE ASSESSMENT PROBLEM

while the method used by Mr. Ruhling gives only approximate values for the triangular shapes.

It is possible to develop definite equations for triangular shaped lots, the values of R may be computed for each foot of depth, and then it is only necessary to multiply these values by the base of the triangle to get the total number of units in the area. The method is as follows:

Consider the equation R equals $y^{\frac{1}{2}}$. This is a mass equation, as for any depth y the value of R is the total of all units up to the depth y. The number of units for a unit area at any depth can be obtained from the first derivative of this equation, or, if r equals the number of units per unit area, r equals $dR/dy = 1/2y^{\frac{1}{2}}$.

Take the three fundamental forms, Cases I, II and III.

Case I—The number of units on any strip, distance y from the street, is $rbdy$, and the total in the lot equals

$$\int_0^h \frac{b}{2y^{\frac{1}{2}}}\,dy = R_I = rxdy$$

$$\text{or } R_I = \int_0^h \frac{b}{2y^{\frac{1}{2}}}\,dy = bh^{\frac{1}{2}} = \text{original equation.}$$

Case II—Total unit in strip

$$xdy = \frac{xdy}{2y^{\frac{1}{2}}} = rxdy$$

$$x = \frac{y}{h}\,b$$

$$R_{II} = \frac{b}{2h}\int_0^h \frac{y}{y^{\frac{1}{2}}}\,dy = \tfrac{1}{3}\,bh^{\frac{1}{2}}$$

Case III = Case I minus Case III = $\frac{2}{3}bh^{\frac{1}{2}}$

Therefore, to obtain the number of assessment units for Case I it is only necessary to multiply the base of the area by the square root of the depth; Case II is one-third and Case III two-thirds of that value. No tables need be computed, as Carnegie, Trautwine, etc., give square roots from 1 to 1000.

The gradation of rates as given by Mr. Ruhling's formula has the advantage of being more easily explained to the property owners. It is easier to say that each 50-ft. strip is one half the value of the preceeding strip, than to say that the assessment varies as the square root of the depth of the lot.

His formula, 2 minus $2^{(50-y)/50}$ can be used in the same manner as the above. To put it in a little better form,

$$R = 2\left(1 - \frac{1}{2^{y/50}}\right)$$

$$\text{Then } r = \frac{dR}{dy} = \frac{2\ln 2}{50}\cdot 2^{-y/50}$$

Integrating this expression over a rectangular area, gives, as before, the starting formula:

$$R_I \text{ equals } 2b\left(1 - \frac{1}{2^{y/50}}\right)$$

Case II:

R_{II} equals the number of units in lot

$$= \int^h rxdy$$

$$R_{II} = \frac{b}{h}\cdot\frac{2\ln 2}{50}\int_0^h y(2^{-y/50})dy$$

$$= \frac{b}{h}\cdot\frac{2\ln 2}{50}\left[-\frac{50}{\ln 2}\cdot 2^{-h/50}\left(h + \frac{50}{\ln 2}\right) + \left(\frac{50}{\ln 2}\right)^2\right]$$

Simplifying this equation, letting $\ln 2 = 0.69313$, we have,

$$R_{II} = \frac{b}{h}\left[144.27 - \frac{1}{2^{h/50}}(2h + 144.27)\right]$$

R_{III} equals R_I minus R_{II}.

Compute tables for values of R_I/b and R_{II}/b, and it is then only necessary to multiply the base of the area by the tabular values for any depth h.

To show the difference in results by using this method in comparison with that of Mr. Ruhling, the values of R_{II}/b by the two methods are shown below for values of h equal to 50, 100 and 150 ft.

h	RII/b This Method	$R(II)/b$ Mr. Ruhling
50	0.44200	0.44500
100	0.58203	0.58375
150	0.59158	0.59292

It will be noticed that Mr. Ruhling's method gives results precise only to the second significant figure. His table for rectangular lots is computed to the sixth figure. The tables for triangular lots should have the same degree of precision.

In practice, the measurements in the field are seldom taken closer than to the nearest $\frac{1}{10}$ ft. which would at the most be to only four significant figures. Therefore, the tables need to be computed only to four places. Besides saving an indefinite amount of work, the results would be just as accurate.

The especial merit of the exact method is that it allows the computation of R_{II} or R_{III} for any depth with any desired degree of accuracy, and it is not necessary to interpolate between 10-ft. intervals, as is the case using the approximate method.

In order to compare the results obtained by using the formulas of the type $R = y^n$, with the formula $R = 2\left(1 - \frac{1}{2^{h/50}}\right)$, I have computed the assessments for the example given in Mr. Ruhling's article, using $R = \sqrt{y}$ and $R = \sqrt[10]{y^4}$ in parallel with $R = 2\left(1 - \frac{1}{2^{h/50}}\right)$

	$R = 2(1 - \frac{1}{2^{h/50}})$	$R = \sqrt{y}$	$R = \sqrt[10]{y^4}$
1. Ed. Adams	46.85	40.60	35.00
2. Ed. Adams	120.38	122.00	122.50
3. Wm. Bond	120.38	122.00	122.50
4. John Jones	192.60	206.20	223.00
5. Frank Watson	96.30	85.50	71.50

Case 1. Triangular lot, apex at street; depth 100, width 50
Case 2. Rectangular lot, apex at street; depth 100, width 50
Case 3. Rectangular lot, apex at street; depth 100, width 50
Case 4. Rectangular lot, apex at street; depth 120, width 50
Case 5. Rectangular lot, apex at street; depth 120, width 50, but with case 2 intervening between it and street.

It is a question which of these three equations gives the most equitable results in the final assessment. For ease of manipulation there can be no question as to $R = \sqrt{y}$ being the best of the three.

Athens, Ohio. RAYMOND D. GLADDING,
First Lieutenant, Engineers, United States Army.

Groined Arches or Flat Roof for Concrete Reservoirs

Sir—The question of which type to use on concrete reservoirs—groined arches or flat reinforced-concrete roof—discussed in *Engineering News-Record* of Sept. 18, 1919, p. 566, is one which has always been of great interest to me and to which I have devoted a great deal of study in connection with the Philadelphia and Pittsburgh filter plants and also the East View and Jerome Park filter plants in the City of New York.

The final result has always shown that the question is determined by the loads involved. If, as is usually the case in the northern United States, the reservoir is to be covered with 2 to 4 ft. of earth to keep out frost, the decision is in favor of groined arches; if the load is less than 2 ft. of earth, then the decision may be in favor of a concrete slab. With 2 ft. or more of earth load the amount of concrete in the flat slab is as great as in the groined arch and the cost of reinforcement is, of course, an extra expense.

The cost of forms need not be considered in any reservoir which is large enough to allow the groined-arch forms to be constructed in a mill on the job and used at least five times. On the Philadelphia filters, Torresdale Plant, the labor cost of building these forms was only $7 per 1000 ft. b.m., and the cost of taking down, moving and setting up was less than in similar reinforced-concrete work. The labor cost of placing the concrete at the above plant was only about 20c. per cubic yard; the additional trouble of shaping the top surface when the men got used to it being apparently less than the trouble of working around the reinforcement in the flat slab. These costs, of course, were average costs on a large job at a time when labor was only about 15c. per hour and plentiful. On a small job, of course, bidders may favor the reinforced-concrete roof on account of the greater familiarity of ordinary workmen with this type of construction and of greater salvage of form lumber, if conditions permitted its use less than five times.

A groined-arch roof, it is true, must be loaded with some degree of care, if loaded while still incomplete; on the other hand, it will probably sustain greater accidental loads than the reinforced-concrete roof, without damage. For instance, on the Pittsburgh filtered-water reservoir I saw a conical pile of dirt, 15 ft. high, placed by a cableway on top of a bare roof, without a sign of failure, whereas a similar accidental load on a reinforced-concrete roof would probably have caused failure.

One point which has not been raised in the discussion in the matter of drainage. In filters, of course, drainage is taken directly through the roof into the interior. In pure-water reservoirs, however, drainage is necessarily prevented from entering the reservoir, and where this entails much expense it is a point to be considered in favor of the reinforced-concrete roof, as the depressions over the piers in the groined-arch roof do not have to be reckoned with. T. C. ATWOOD,
District Plant Engineer,
Baltimore, Md. Emergency Fleet Corporation.

Plane-Table Has Another Champion

Sir—There have been a number of divergent opinions expressed in the discussion of "Transit or Plane-table for Topography?" in your issues of July 10, Aug. 14 and Aug. 28, 1919. I should like to see this discussion continued.

My experience of some years in topographic mapping is entirely in favor of the plane-table, no matter what the conditions regarding the scale of the map, contour interval, amount of detail to be shown, or whether the area is timbered or cleared. I think from their letters in your issue of Aug. 14, 1919 that Fred Vernon and F. J. Howes both concur in this opinion.

Kenneth Allen in his letter of the same issue, and Emile Low, in a letter in the issue of Aug. 28, 1919, express other views. Mr. Allen would limit the use of the plane-table to large-scale maps, having a small contour interval, and where the country is open. Mr. Low thinks its use for taking topography along a railroad survey, not a reconnaissance, is not defensible. He also controverts the statement made by Mr. Howes that "a plane-table will give accuracy greater than that obtained by common methods." Yet both of these gentlemen substitute methods embodying the plane-table principle, which methods seem to me to have disadvantages not found in the plane-table proper, and at the same time do not offer any advantage of either accuracy or speed of operation. I agree with Hargraves Wood in his statement that one often sees descriptions of ingenious and often laborious methods to accomplish what could have been done more easily with the plane-table. I am at a loss to understand why this should be. My experience is that there are many different ways of operating a plane-table, each being best adapted to a particular class of work—one for large-scale maps showing a great amount of detail, another for small-scale maps of large areas, still another for timbered areas.

Certainly, the general success with which the plane-table has been used by the United States Geological Survey in mapping large areas would seem to be against Mr. Allen's contention that its use be limited to large-scale, detailed maps in open country. I fail to see any advantage in the method that he desires to substitute; namely, of transit with vertical arc and stadia and a small plotting table. With proper horizontal and vertical control, the telescopic alidade with

stadia and vertical arc will give equally accurate results—results well within any plotting scale. His method seems to me to have the disadvantage of having to read the horizontal angles and then the inaccuracy of having to plot those angles by protractor, introducing two chances of error, one in reading and the other in plotting. With the alidade these operations are eliminated, the alidade is set on the rod and the line drawn in its correct direction. He has the further disadvantage of having his original map drawn on small sheets, while with the plane-table the original maps are of a very convenient and useful size, 24 inches by 30 inches.

As to Mr. Low's position, I think he is in error and that Mr. Howes is correct. The accuracy with which the map as a whole represents the topography of the area will be greater where the plane-table method is used than that attainable by any other, with the same expenditure of time and money. The method of hand level along cross-section lines, working from known center-line elevations, locates the position of the contours at these cross-section points, but does not give accurate information concerning the position of the contours between these points. They are interpolated, or guessed in. With the plane-table one would work from the same known center-line elevations, determining the position of the contours with telescopic alidade, more accurately than with hand level. The position of every point of change of the contours would be thus determined and the intermediate portions drawn, with the topographer looking at and interpreting the ground he was trying to represent. The resulting map should be from 90 to 95% correct.

During the rush of war work I had opportunity to observe a number of field parties working side by side, using various methods of taking topography, each using the method with which the members were most familiar, and therefore with which they were most expert. This happened on at least four different jobs with as many different sets of men. In each case the honors were with the plane-table parties, both as to excellence of results and the economy and speed of obtaining them. On one occasion, the survey of approximately 3000 acres, the transit and plane-table parties were equal in number. The plane-table parties mapped seven-tenths of the area and the transit parties three-tenths. The quality of the work was about the same—if anything, in favor of the plane-table work. Upon working up the costs I found that if the entire area had been surveyed by the plane-table parties the cost would have been $1200 less than if it had been done by the transit parties.

In this connection, it may be of interest to quote from an address on cantonment construction, made to the Engineering Society of Western Pennsylvania, by Morris Knowles, supervising engineer at Camps Meade and McClellan. In describing the surveys he makes the following statements:

"A word as to the excellence of the plane-table work may not be amiss. Our own local experience would have led us to carry on this work by stadia, in the customary way with which so many of us are familiar; but if we had any misgivings at all as to the advantages of plane-table work they soon disappeared with the general success which we attained both at Camp Meade and Camp McClellan. It is our opinion that in no other way could the work have been done so quickly and satisfactorily as by the plane-table method."

Mr. Howes says: "Considerable experience is necessary to operate a plane-table efficiently. That is perhaps the reason why one never sees a plane-table in a railroad survey party." He excuses this on the ground that: "It is more nearly the rule than the reverse that railroad location parties are organized hurriedly for a limited amount of work. New men must be broken in to take topography, and, naturally, they must be taught the simplest method first." There is a great deal of truth in what he says; I would even go further and say that in many cases the engineers in charge would not use the plane-table even where experienced operators are available. But is not Mr. Howes' excuse an indictment rather than an excuse? Is it fair either to the client or the project to use makeshift methods in obtaining basic data upon which plans for large expenditures are to be made? Can one be sure that the one best location of a railroad is obtained unless the surveys are accurate and comprehensive? Is it fair to the client if methods of making these surveys are used that are more costly and less efficient than some other method? Is it a fact that the engineering profession attaches so little importance to the matter of obtaining complete and accurate basic data that there are not men sufficiently trained to make such surveys in a proper and economical manner? If so, then it is possible that the estimate of the profession, by the general public, as reflected in engineers' salaries, is more nearly correct than many of the recent letters appearing in your paper would indicate.

WILLIAM N. BROWN,
Of Brown & Clarkson. Civil and
Washington, D. C. Mining Engineers.

Constructors' Versus Designers' Pay

Sir—With reference to your editorial in the issue of Sept. 18, 1919, p. 539, concerning "Constructors' Versus Designers' Pay," I should like to take up the case for the designers, which was made especially prominent in the ruling of the Director General of Railroads, where engineers not on the supervisors' list were classed as "clerks." In several instances of which I know personally, young engineers with slight technical training, but who happened to be in charge on an outside job, received supervisors' rating and were given increases ranging from $40 to $80 per month, while men with university degrees, who had spent years of study on their particular lines of design, received no increase or a very small amount in comparison.

I cannot quite see the justice of such a procedure, and if continued it would discourage any young man from spending the time and money to enable him to do intelligent designing work. The more intensive training demanded of the good designer should at least bring him as great a monetary reward as that granted the supervisor.

The loss in efficiency and money due to a faulty and uneconomical design could not be compensated for by the most careful outside supervision. I do not think that sufficient recognition is given the time and trouble involved in compiling data and increasing a man's knowledge, which would enable him to produce a proper design. From one who has done both classes of work.

Elizabeth, N. J. WALTER E. BROWN.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Contractors' Tool Records Kept on Two Form Sheets

STOCK sheets which show the location of every tool of each kind, and tool lists which catalogue all tools for each class of work, enable the superintendent for any construction being performed by Villadsen Brothers, Inc., contractors, Salt Lake City, to requisition quickly the equipment wanted for his work, and also enable a clerk to fill this requisition with precision from stock or from another job or by purchase. The record prevents duplication, lessens the risk of overlooking essential items, preserves uniformity of equipment and checks losses.

The basis of the equipment records is the order blank. Order books are kept in the main office and at every job office, and it is a fundamental rule that no foreman shall allow anything of value to come to or to go from his work without a charge or a credit order. These orders are made in triplicate, the original going to the consignor, a copy going to the home office, and a copy remaining in the order book. The copies coming to the home office are the basis of the equipment records. From them the entries on the stock sheets are made.

One stock sheet, Fig. 1, is provided for the record of each article. Two articles are never grouped on a stock sheet unless they are interchangeable in use. For example, a wooden-handled wheelbarrow and an iron-handled wheelbarrow of the same capacity would be entered on the same sheet, but even here a change to separate listing is being considered because all the parts are not interchangeable. The sheets are kept in a loose-leaf binder, and there are now 350 sheets in the records of the contractors named. A search of any sheet shows where every article of the kind recorded by that sheet is located.

To facilitate search, each tool receives a number, which establishes its order in the stock sheets. These tool numbers are similar to catalog numbers in a hardware catalog. They run from A1 to M79; all tools in class A, for example, being concreting equipment and all in Class M being hand tools. Besides the class arrangement of the tools, there is also an alphabetical index, again similar to a hardware catalog.

The second feature of the equipment records is the tool list, Fig. 2, which is a complete list of tools arranged according to class or use. Many copies of this list are made on the multigraph, so that each job can have its list. In equipping a job, the number of pieces required is first entered opposite each item; then, in successive columns, the number to be taken from the store house, the number to be bought new, and the number that can be spared from job 166, 173, 175, etc. The entries so far are made by the general superintendent. From the superintendent's list, orders to equip a job can be made up by a clerk, requisitioning so many pieces from the hardware store, and so many from each job. There is also a place to enter up the material returned at the end of the job, so that any leakage of tools can be checked. The classifications of tools, which are carried

Other Articles in This Issue of Interest to Contractors:

Concreting Procedure on Miami Flood-Control Dams — Page 640

Notes on Army's Light-Railway Practice in France — Page 653

Large Paving Mixer Puts in 180-Yard Slab Every Hour — Page 658

Machines Take the Place of Men on 20-Mile Concrete Road — Page 664

Criticisms of Contract Bond Business Answered — Page 669

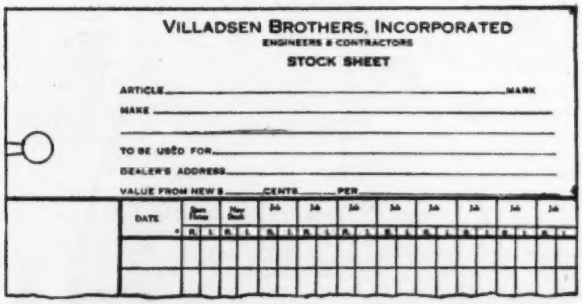


FIG. 1. STOCK SHEETS SHOW DISTRIBUTION OF STOCK OF EACH PARTICULAR KIND OF TOOL

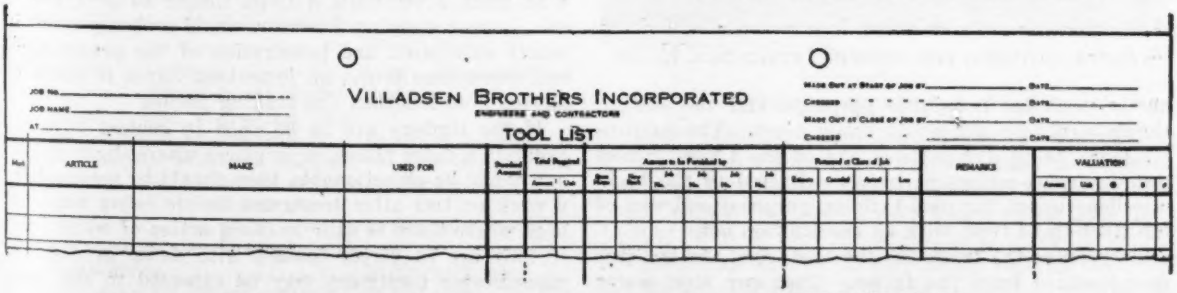


FIG. 2. TOOL LIST SHOWS ALL TOOLS ARRANGED ACCORDING TO CLASS

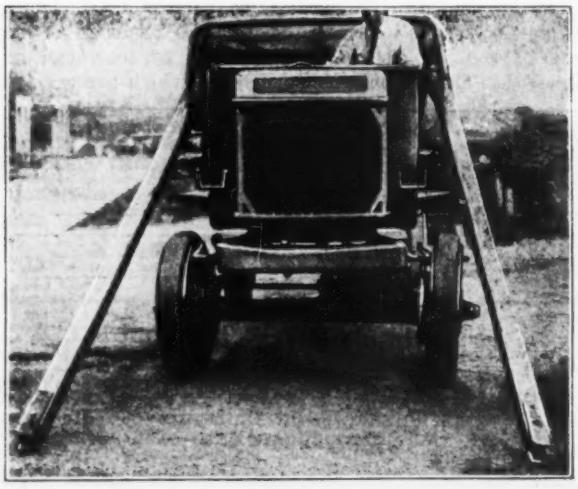
on a side-index on the sheets, are: Concrete equipment, hoisting equipment, saw-mill equipment, electrical equipment, reinforcing equipment, instruments, miscellaneous, water-supply and temporary heating, grease and oil, belting and hand tools. A supplementary account of rough hardware and construction material on hand is also run.

Carpet of Screenings Insures Clean Aggregate

BROKEN stone and screenings for concrete base on a Chicago paving contract are deposited in adjacent piles at intervals on the subgrade. The screenings, which are used as sand, are piled first; then, from the pile, shovelers spread about an inch of material on the subgrade over the area to be occupied by the pile of broken stone. On this carpet the stone is piled. The advantages of the practice are: (1) The shovelers in loading from the stone pile do not tear up the surface of the subgrade; (2) the bottom layer of stone does not lie on the dirt, and in shoveling no dirt is taken up with the stone, and (3) the shovel is easily forced through the fine material under the stone, and shoveling is nearly as easy as from a platform.

Improvised Method for Dumping Fixed-Box Motor Trucks

DUMPING fixed-box motor trucks by the method shown in the accompanying illustration has been resorted to in the maintenance division of the New York State Highway Department. It is often convenient to have some means of dumping a truck which is ordinarily used for non-dump purposes, and the method shown might be utilized in many cases. The particular truck being dumped was one of the United States Army surplus-equipment trucks delivered to the highway department for road-building purposes and was of the Nash-Quad type, with an ammunition box.



STRUTS ADJUSTED FOR DUMPING FIXED-BOX TRUCK

To prepare the truck for the operation, the box was first loosened from the frame. Then two steel plates with bolt holes in them were fastened to the sides of the box at the rear end to form a hinge. The connection with the frame was made by removing the trailing hooks and using the holes to pass the hinge bolts through. A beam reinforced with a steel plate on the under side was placed over the front end of the box and fastened by two rods extending from a king pin at its center to the lower front corners of the box. This allowed the beam to act as an evener between the two struts projecting in front of the truck. The struts, which are 11 ft. long in this instance, are provided with bearings which pass over pins placed in the ends of the beam. They are shod with strap-iron plates at the lower end to keep them from sliding.

To dump the box, it is simply necessary to adjust the struts and start the truck, the front part of the box being raised as the truck moves forward. The struts are made of such length that they will be vertical when the box is high enough to dump, and as the truck proceeds the box is lowered to its former position.

This method is not recommended for constant use, as it puts a strain on the truck frame for which it is not designed, but for occasional use it is satisfactory. The method was developed by Guy W. Pinck, assistant engineer in charge of maintenance for the sixth division.

Job Treatment of Timber by Steeping in Zinc Chloride

TREATED timber for temporary construction structures can be prepared by the contractor on the job by the zinc chloride steeping process. The only apparatus required is a wood, sheet-iron or concrete tank large enough to submerge any timber to be treated. The timber must be seasoned, and if it has to be framed the framing should be done before treatment. The directions for treatment, as given in a recent circular issued by the United States Forest Products Laboratory, are as follows:

Zinc chloride can be purchased either in solid form or in a 50% water solution. For treatment by the steeping process it should be dissolved in water to form a 5% solution. This can be done by mixing 5 lb. of the solid zinc chloride and 95 lb. of water, or 10 lb. of the 50% solution and 90 lb. of water. The solid form absorbs water from the air rapidly and will soon dissolve itself in this way. It should, therefore, be mixed in solution as soon as the package is opened.

As the timbers are being piled into the vat, spacers should be placed between the courses, so that the preservative solution will be able to reach every part of each stick. It is customary to allow the wood to soak one day for each inch of thickness, and one additional day. Thus, a 1-in. plank should soak two days, one 6 in. thick, seven days, a 12-in. timber 13 days, and so on. Longer steeping, however, would probably result in better absorption and penetration of the preservative, and when time is not an important factor it would be advisable to lengthen the soaking period.

If the timbers are to be used in contact with the ground, in damp places, or in places where slight shrinkage would be objectionable, they should be seasoned for a week or two after treatment before being used. If used where there is little leaching action of water, even if they are in direct contact with damp ground, the zinc-chloride treatment may be expected to add more than enough to their length of life to justify the cost of treatment.

Proposed Schedule of Salaries for State Highway Engineers

Preliminary Report of American Association of Engineers' Committee Submitted for Discussion Before Adoption

PROPOSED salary schedules for highway engineers, as suggested in a preliminary report of the Committee on Salaries of Engineers in Public Service, of the American Association of Engineers, are herewith submitted for discussion before being finally submitted to the association for adoption. It is suggested by the committee that highway engineers gather at their respective headquarters for consideration of the report and make suggestions for betterment. It is necessary that these reach the committee by Oct 15, so that the schedule may be revised and adopted before the state budgets are made up for the coming year.

The Committee on Salaries of Engineers in Public Service consists of S. C. Hadden, editor of *Municipal and County Engineering*, J. H. Prior, consulting engineer on public utilities, Chicago; A. R. Hirst, state highway engineer, Wisconsin; F. H. Newell, president of the association, and A. N. Johnson, chairman, consulting highway engineer of the Portland Cement Association. Preliminary to drafting the schedule for highway engineers, the following were invited to serve as corresponding members of the committee: Thomas H. McDonald, chief of United States Bureau of Public Roads; W. L. Basset, Bureau of Municipal Research, New York; Col. W. D. Uhler, chief engineer of the Pennsylvania State Highway Department; A. B. Fletcher, state highway engineer of California; A. W. Dean, chief engineer of the Massachusetts Highway Commission, and Clifford Older, chief engineer of the Illinois State Highway Department.

In studying the problem, the committee has endeavored to price engineering service and not to standardize and classify it. It does not suggest a plan of organization, but has attempted to list the titles and duties of the different grades in such a way that the engineers of all highway departments can be readily placed.

Proposed Schedule of Salaries for Engineers in State Highway Service

Administrative and Executive Positions

Assigned to state and division headquarters and having general duties as indicated by titles:

Chief engineer,	$8,000 to $15,000
Engineer of construction,	$6,000 to $10,000
Engineer of maintenance,	$6,000 to $10,000
Engineer of bridges,	$5,000 to $ 8,000
Office engineer,	$5,000 to $ 8,000
Engineer of tests,	$4,000 to $ 7,000
District engineer, in charge of all work in district or division,	$5,000 to $ 8,000

Engineering Positions Involving Some Administrative Duties in the Higher Grades

Advisory and consulting engineer to the chief engineer,	$5,000 to $10,000

First assistant engineers assigned to state and division headquarters and in general charge of office work:

First assistant engineer of construction,	$3,600 to $ 5,000
First assistant engineer of maintenance,	$3,600 to $ 5,000
First assistant bridge engineer,	$3,600 to $ 5,000
First assistant division engineer,	$3,600 to $ 5,000

Assistant engineers assigned to state and division headquarters:

Assistant engineers assigned to engineer of construction,	$2,400 to $ 4,000
Assistant engineers, assigned to engineer of maintenance,	$2,400 to $ 4,000
Assistant engineers, assigned to bridge engineer,	$2,400 to $ 4,000
Assistant engineers in office at state headquarters,	$2,400 to $ 4,000
Chief chemist, testing department,	$3,500 to $ 5,000
Assistant engineers, assigned to division headquarters, for field and office work on construction and maintenance,	$2,400 to $ 4,000
Assistant engineers, assigned to laboratory work,	$2,400 to $ 4,000
Assistant chemists, assigned to laboratory,	$2,000 to $ 4,000
Chief draftsmen, assigned to division headquarters,	$2,400 to $ 4,000
Chiefs of survey parties, field and office work,	$2,400 to $ 4,000

Inspectional Service

Assigned to State Headquarters

Confidential inspectoros, assigned to chief engineer	$4,000 to $ 5,000
General inspectors of maintenance,	$2,400 to $ 4,000
Inspectors of bridge construction,	$2,400 to $ 4,000
Field inspector of materials, testing department,	$2,400 to $ 4,000

Assigned to division headquarters for both field and office work:

Inspectors of construction,	$2,400 to $ 3,000
Inspectors of construction, employed during working season only, per month,	$ 250 to $ 300

Junior Positions Concerned with Routine Work Only

Assigned to state and division headquarters, various departments:

Engineering draftsmen, computers, checkers, estimators, assigned to state headquarters,	$1,800 to $ 2,400
Tracers, computers, checkers, assigned to bridge engineer,	$1,800 to $ 2,400
Engineer draftsmen, assigned to division headquarters,	$1,800 to $ 2,400
Instrument men, employed on field and office work,	$1,800 to $ 2,400
(If employed only during construction season, per month,	$ 200 to $ 250)
Rodmen and chainmen,	$1,200 to $ 2,400
Laboratory assistants,	$1,800 to $ 2,400

All engineers working away from state or division headquarters to which they may be assigned are to receive traveling and subsistence expenses.

This schedule not to operate to reduce present salaries.

A. N. JOHNSON, Committee on Salaries of Engineers in Public Service, American Association of Engineers, 63 E. Adams St., Chicago, Ill.

Excessive Rainfall at Manila

Record-breaking rainfall at Manila, P. I., occurred during recent typhoon weather, according to information sent to *Engineering News-Record* by A. F. Hillberg, Manila. In the 17 days which ended Aug. 10 a total of *3 in. of rain fell, or within 17 in. of the normal annual precipitation. On July 29 the rainfall was 11.56 in., the heaviest since American occupation, and on the day before it was 7.69. The precipitation exceeded 5 in. on six out of 17 days.

NEWS OF THE WEEK

New York, October 2, 1919

Interstate Agreement on Hudson River Tunnel

New Jersey and New York have entered into formal agreement through their Interstate Bridge and Tunnel Commissions to build and operate the vehicle tunnel under the Hudson River, for which initial legislative appropriations were made last spring. At that time authority was given to the commissions to contract with each other for the purpose; details of the agreement have been under discussion since. An important clause of the contract protects either state in case of default by the other, there being no obligation to make further appropriations. In the event of any default, the other state may complete construction and collect tolls at both portals until the cost in default is repaid. Taxes of either state must be collected from the toll income taken on its own side. The tolls are to be fixed at such a rate as to repay principal and interest within 20 years.

Intensive Drive for Members by Western Society

In order that it may play a part commensurate with the technical and welfare demands of engineers in Chicago, the Western Society of Engineers will undertake in the week beginning Oct. 5 an intensive campaign for increasing its membership. A survey has indicated that there are over 4000 technical men in Chicago eligible to membership in the society who are not now members, and it is hoped to add at least 2000 of these to the rolls by the close of the campaign on Oct. 11. The membership has been divided up into teams, each under a captain, and the campaign for members has been placed on a competitive basis among these teams.

Fourth Lock at the Soo Opened

On Sept. 18, 1919, the fourth lock at the American Canal at Sault Ste. Marie was thrown open to traffic. This is a companion lock to the so-called Davis or third lock, which was put into service in 1914. Each lock is 1350 x 80 ft. in plan and has a depth of 24.5 ft. over the miter sills. Construction on the fourth lock continued throughout the war, though this last part of the work had to be done by force account. The lock has been named the Sabin Lock, in honor of L. C. Sabin, the general manager of the canal and an engineer who has been connected with the work at the Soo for many years.

Employment Bureaus

Engineering Societies' Employment Bureau of the four founder societies, conducted by Engineering Council Employment service, for members and for other professional men introduced by members. Especial attention for those released from Government service. Address, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 505 Pearl St.

Downtown Street-Car Subways Proposed for Detroit

Rapid-transit studies for Detroit by Barclay Parsons & Klapp, consulting engineers, have resulted in the planning of downtown street-car terminal loop subways. H. M. Brinckerhoff, who has directed the studies, last week laid before the city authorities the plans for this loop system. The subways are intended primarily to relieve street congestion by removing from the surface most of the cars now using the downtown streets, thereby also permitting street-car service to be increased. In addition, they are to constitute the initial element of a rapid-transit system.

Two subway loops are projected, one in Woodward Ave. and one in Fort St. The Woodward Ave. subway would begin near Adelaide St. and extend to a loop near Atwater St., with five stations. The Fort St. subway would begin west of Cass Ave., pass under the Woodward Ave. subway and terminate in a loop at Cadillac Square, which would also constitute the transfer station for eastbound surface cars. At the main transfer station, just north of the City Hall, traffic would interchange between the two subways.

The plan is regarded favorably by the city officials, and it is reported that they intend to seek a popular vote on a bond issue before the end of the year.

Bills for Transfer of War Equipment for Road Building

Authorization granted to the Secretary of War for the free transfer of road-building equipment to the Department of Agriculture is included in a bill introduced Sept. 22 by Representative Kahn and referred to the Committee on Military Affairs. It authorizes the transfer of surplus motor-propelled vehicles and motor equipment to the Postoffice Department, the Navy Department, the Treasury Department, the Public Health Service and the Department of Agriculture.

The equipment to be transferred to the Department of Agriculture "for use in the improvement of highways and roads" includes surplus motor-propelled vehicles, motor equipment, road rollers, graders, concrete mixers, derricks, complete piledriving outfits, etc.

Representatives of the Director of Sales and of the Chief of the Bureau of Public Roads this week agreed on the main points of a bill providing for the transfer of surplus Army equipment suitable for road work. The measure was reported to the Senate Sept. 24.

The Senate committee, at the suggestion of Thomas H. McDonald, chief of the Bureau of Public Roads, inserted an amendment authorizing the state highway departments to rent the equipment to state or municipal agencies for road-building purposes.

Proposes Regulating Discharge of Lake Ontario

Regulation of the discharge of Lake Ontario into the St. Lawrence River has been proposed by F. C. Shenehon, consulting engineer, in a report to the Sanitary District of Chicago. This would be independent of but supplementary to the proposed regulation of the Niagara River in order to control the levels of Lakes Erie, Huron and Michigan. The Ontario plan provides for piers in the Galops channel on the American side, carrying bridge spans of 180 ft. Each span would carry hinged beams which could be lowered to rest on the bottom of the channel and between which sliding panels would be lowered to close the waterway. Thus the channel could be regulated so as to reduce the flow in time of low water and to provide ample discharge in case of high water or flood. The cost is estimated at $1,000,000, with annual operating expenses of $25,000, while the works could be built in two years. For the Niagara controlling works the first cost and annual expenses are estimated at $1,224,000 and $50,000.

Highway Engineering Fellowships Offered in Michigan

Several fellowships in highway engineering at the University of Michigan will be awarded about Oct. 10, according to an announcement made by Arthur H. Blanchard, professor of highway engineering. The allowances, conditions, and subjects of investigation are as follows:

The Detroit Edison Fellowship, contributed by the Detroit Edison Co.; allowance $500 per year, with $100 for expenses; subject, study of moderate-cost country roads.

The R. D. Chapin Fellowship, contributed by R. D. Chapin of Detroit, president of the Hudson Motor Car Co.; allowance $500, with $100 for expenses; subject, study of hard-surfaced roads and pavements.

Appointments for 1919 and 1920 have not been made, and all candidates applying up to Oct. 10 will be considered. A fellow must have a bachelor's degree in civil engineering from a college of recognized standing; must enroll as a candidate for the degree of master of science in engineering, and be in residence at the university for eight months.

Manager for Des Moines Water-Works Under City Ownership

Making appointment under a pending ordinance, the Board of Water-Works Trustees of Des Moines, Iowa, will select a manager for the local water-works after the plant is taken over from the Des Moines Water Co., about Oct. 1. The city will pay $3,535,000 for the works, which sum includes $75,000 for improvements made since Jan. 1, 1919. The valuation was made by Alvord & Burdick, Chicago, for the company, and W. S. & E. W. Bemis, Chicago, and Karl C. Kastberg, city engineer of Des Moines, for the city. Four elections were held before the city could buy the works. In 1898 a vote to purchase for $850,000 was cast, but the necessary bond issue failed. In 1905 a favorable vote was voided by a technicality. In 1912 a numerical but not a legal majority of voters declared for purchase at $2,250,000. The last legislature authorized purchase on a numerical majority vote, and at an election held Aug. 15, 1919, the vote was 2773 for purchase and 1998 against. All but 90 of the 205 miles of mains in the distribution system have been laid since 1900.

Work Progressing on St. Louis Municipal Dock

The City of St. Louis is this year spending $300,000 on the municipal dock which has been under construction for some years. The dock wall is being extended to a total length of 900 ft., the construction of pile fenders upstream and downstream from the concrete wall making the total length about ½ mile. There also is being built a warehouse with 60,000 sq.ft. of floor space and the necessary railway tracks and roadway in connection with the whole terminal. The construction work is being performed by city forces, and the city Supply Commissioner will purchase mechanical equipment on specifications furnished by the city.

Propose Enlarged St. Lawrence Canal System

Preliminary surveys are being made by the Canadian Government looking toward the construction of a St. Lawrence canal system capable of taking ships of the size to be accommodated by the Welland ship canal when that canal is completed. The new Welland ship canal has a miter-sill depth of 25 ft., which is greater than the depth over the present St. Lawrence marginal canal. The new project would include a new canal extending from Cardinal to Cornwall, would do away with the locks at Cardinal, Morrisburg, Fabians Point and Cornwall, and would involve a new canal farther back from the river than the present one.

American Association of Engineers To Admit Architects

The Executive Committee of the American Association of Engineers has decided that the constitution of the association does not prohibit the admission of architects, and has announced that applications of architects will hereafter be considered.

Governor of Virginia Signs New Highway Laws

Several highway bills were recently signed by Governor Davis of Virginia, and it is believed they will mark the beginning of unprecedented road construction. The new legislation provides for the levy of additional road funds, the formation of a state highway commission, appropriations for county aid by the state, and increases in the automobile license tax.

The new State Highway Commission will consist of five members appointed by the Governor and subject to the approval by the Senate. It is provided that, as far as possible, each of the five geographical sections of the state shall have representation on the commission, which will assume its duties Nov. 1. The commission does not displace the present State Highway Commissioner, with whom is left the jurisdiction in all matters which come in the civil-engineering field.

An additional levy of 7c. on general property, to be used in meeting the Federal aid for building and maintaining highways, is provided for in another bill. Another bill increases the automobile license tax from 40 to 60c. per horsepower, the increase to be devoted to state-road construction. Funds derived at the old rate of 40c. will still continue to be used for highway maintenance only.

Development Committee Writes Final Report

The Development Committee of the American Society of Civil Engineers met at the Michigan Union, Ann Arbor, Mich., last week to write its final report, which is to be presented to the board of direction of the society at its October meeting.

In the week before last the conference committee of the development committees (representing the four founder societies) met in New York City and agreed to a report which has been transmitted to the respective development committees.

American Society for Testing Materials in New Headquarters

Removal of the headquarters of the American Society for Testing Materials from the University of Pennsylvania to 1315 Spruce St., Philadelphia, took place recently. With this removal the society for the first time in its history occupies an independent home. Since its foundation twenty years ago its business has been conducted in the office of the late Prof. Edgar Marburg, secretary and treasurer of the society, at the University of Pennsylvania. The new quarters are located in the building of the Engineers' Club of Philadelphia, the third floor of which is now being fitted up for the society.

Joint Study of St. Lawrence River Started

Announcement has been made from Canada that the Government there has taken action in accordance with the request of the United States for an investigation by the International Joint Commission of the feasibility and cost of an international scheme for the improvement of the navigation facilities and water-power development on the St. Lawrence River. A suggested conference of this sort was a part of the last United States rivers and harbors bill. The Canadian Government has selected W. J. Stewart of Ottawa, who is Dominion hydrographer, as its representative to act in conjunction with Col. Charles Keller, Corps of Engineers, representing the United States Government, in preparing the question to be presented to the National Joint Commission. In the meantime, surveys have been carried on by the Canadian Government, and the Hydro-electric Power Commission of Ontario has been receiving data and preparing plans.

Railway Bridge Builders To Meet in Cleveland

The American Railway Bridge and Building Association will hold its 29th annual convention Oct. 21-23 in Cleveland, with headquarters at the Statler Hotel. In addition to committee reports, the program includes discussion of renewal of timber bridges, bridge inspection, painting of structural metal and fire-protection equipment.

Ask Consideration of New Pier Handling Methods at New York

Resolutions adopted by the Society of Terminal Engineers and directed to various officials in the City of New York ask that the city consider the desirability of redesigning the proposed Staten Island piers so that some other system of freight handling than the cargo-mast system common to New York City be used. The preliminary designs of these piers show the pier taken up practically wholly with the pier shed, and with cargo masts, which are operated with whip hoists or with the deck engines of the ships. According to the society, this will result in cargo being handled by these new piers in "the same inefficient, expensive and slow manner as it has been handled in the port of New York for the past twenty-five years." The resolutions continue: "Whereas, Staten Island is the only borough of the city in which direct rail connection can be made between docks and the transcontinental lines of the city; therefore be it resolved, that in the design of these piers provision should be made for leading rails on the piers for direct interchange of freight between rail and ocean carriers. Be it further resolved, that it is the opinion of this body that the interests of the port of New York demand that such contracts for erecting and equipping these piers that are let should contemplate that particular type of pier construction which is best adapted to the installation of modern cargo-handling devices and machinery." It is further requested that "the economic advantages of mechanical freight- and cargo-handling devices or machines be given proper recognition as a controlling factor in securing for the port of New York the prestige which its physical advantages should command."

Weights and Measures Laws Being Compiled

Work on the compilation of the weights and measures laws of the various states by the Bureau of Standards is being pushed forward, with a view to the issue in the near future of a new edition of Miscellaneous Publication No. 20, "The State and National Laws Concerning the Weights and Measures of the United States." On account of the great amount of weights-and-measures legislation which has been added to the statutes of a large number of the states since the publication of the last edition in 1912, and because of changes in existing legislation, the last edition has now become obsolete.

Welland Canal Work Shut Down

Certain parts of the construction work on the Welland ship canal between Lakes Erie and Ontario, which was started up a short time ago, have been shut down by order of the Department of Railways at Ottawa, because of labor difficulties. It is understood that the Government recommenced work on the canal, which had been shut down during the latter part of the war, mainly to provide employment as a measure of social relief. During the past month there has been a great deal of labor difficulty on the canal work, largely a demand for higher wages.

$262,000,000 Needed by Reclamation Service

(*Washington Correspondence*)

To complete the going projects of the United States Reclamation Service will cost $112,134,000, according to a statement made by Arthur P. Davis, director and chief engineer, before the House Committee on Irrigation of Arid Lands Sept. 19. Estimates for new projects total about $150,000,000 additional.

By states and projects the estimated cost to complete present projects is as follows:

Arizona—Yuma, $8,050,000; California—Orlando, $2,830,000; Colorado—Grand Valley, $1,870,000, and Uncompahgre, $585,000; Idaho — Boise, $1,050,000; King Hill, $877,000, and Minidoka, $19,805,000; Montana—Huntley, $172,000; Milk River, $5,000,000; Sun River, $3,400,000, and Lower Yellowstone, $260,000; Nebraska — North Platte, $6,580,000; Nevada—Newlands, $6,150,000; New Mexico — Carlsbad, $300,000, and Rio Grande, $5,630,000; Oregon—Umatilla $3,110,000, and Klamath, $3,000,000; South Dakota—Belle Fourche, $640,000; Utah—Strawberry Valley, $1,000,000; Washington—Okanogan, $430,000, and Yakima, $25,605,000; Wyoming—Shoshone, $15,790,000.

The probable cost of proposed new projects was given by Director Davis as follows: Arizona—Parker, $7,600,000; California—Imperial, $52,000,000; Iron Cañon, $18,000,000; Blythe, $4,000,000, and Kings River, $12,000,000; Colorado — Montezuma, $4,000,000; Idaho—Gem District, $1,500,000, and Hansen Butte, $2,200,000; Montana—Bitter Root Valley, $2,200,000; Nebraska—Lower North Platte, $8,400,000; New Mexico—Middle Rio Grande, $6,000,000; Oregon—Owyhee, $2,300,000; Lower Powder River, $4,500,000, and Rogue River, $2,100,000; Texas—Lower Rio Grande, $10,000,000; Utah—Castle Peak, $8,000,000; Wyoming—Riverton, $5,800,000.

On Sept. 20 the Senate Irrigation Committee ordered a favorable report on a bill to appropriate $250,000,000 for reclamation work approved by the Reclamation Service.

Contractors to Consolidate Publications

Arrangements have been made by the Associated General Contractors of America to consolidate the publication of its bulletin with that of the General Contractors' Association, New York City. The new publication is to be known as *The Bulletin of the Associated General Contractors of America.*

Federal Highway Council Takes Up Transport Committee Work

Upon information that the Highway Transport Committee was to be disbanded, the Federal Highway Council, after several conferences among organizations interested in the betterment of highway transportation, decided to take over and continue its work.

The work will be under the supervision of Charles W. Reid as manager of the transportation bureau of the council. He has been chief executive officer of the Highway Transport Committee since its reorganization, and prior to his becoming associated with the committee was vice-president of Rathbone, Sard & Co., of Albany, N. Y., and Aurora, Ill.

Additional Money for River Control Recommended

An additional sum of $1,500,000 should be spent on works to control the waters of the Puyallup, Stuck and White Rivers, according to a report by R. H. Thomson, consulting engineer, Seattle, to the Inter-County River Improvement Board of Pierce and King Counties.

The report accords with that of W. J. Roberts, chief engineer on the inter-county river improvement, who has had charge of the work for five years. This was to have been the last year of the work, but Mr. Thomson says several years more will be required to finish it. Additional bank protection on the rivers, control of the floods at the source by a series of dams and floodgates, and widening of channels under bridges, is recommended.

Postpone Chamber of Commerce Trade Conference

Announcement has been made from the headquarters of the International Trade Conference, Chamber of Commerce of the United States, that the Atlantic City meeting, postponed from Sept. 30, is to be held Oct. 20, on account of lack of transportation for British, French, Italian and Belgian delegates. Announcement regarding the meeting was made in *Engineering News-Record* of Aug. 14, 1919, p. 343.

Date of City Managers' Meeting Advanced

The date for the sixth annual meeting of the City Managers' Association has been advanced from Oct. 29-31 to Oct. 27-29. It will be held at Indianapolis, as previously announced, with headquarters at the Claypool Hotel.

Bridge Pier Drops Span

During reconstruction of an underscoured center pier of a highway bridge over the Mohican River near Greer, Ohio, Sept. 17, the pier fell over shortly after the two 125-ft. spans resting on it had been placed on falsework. One of the spans was wrecked by the fall.

New York Trying to Encroach on North River Channel

Relocation of the pierhead line on the Hudson River at the southern end of Manhattan Island is desired by the City of New York, and Dock Commissioner Hulbert has made application to the Harbor Line Board to that effect. Maj. Gen. W. M. Black, chief of engineers, has returned the application with various comments, the principal of which reduces it to the conclusion that this is another of the attempts on the part of the City of New York to encroach on the channel of the river. The present application relates to the widening of West St. below Rector St. so as to make that part of the marginal street as wide as the part north of Rector St. The request is that 85 ft. be added to the pierhead line. General Black's recommendation points out that if the desired extension of the pierhead line were granted it would create a reëntrant angle in the line at the upper end of the proposed change, and thus introduce into the situation a temptation to rectify the line at some future time by drawing a straight line from the outermost part of the extension to some point in the line at Chelsea, and that any extension of the pierhead line in this vicinity would be so much encroachment upon the deepwater channel, which is already too narrow and which the Federal Government proposes to widen by dredging along the New Jersey side of the channel. Commissioner Hulbert, in a letter to the Merchants' Association, states that the width of the river at the point under consideration is 3870 ft., as against 2775 ft. between Chelsea and Hoboken.

Ask Appropriation for Relief of Contractors

The Treasury Department has asked for an appropriation of $500,000 to be expended under the act for the relief of contractors and subcontractors on public buildings. In submitting the request for the fund, Secretary Glass stated that he understands a number of the claims are in such shape as to permit of their approval and immediate payment. Further appropriations will be requested as necessity arises.

Irrigation Bond Issue Voted in Imperial Valley

At a bond election held in Imperial County, California, Sept. 15, the proposition for issuing bonds in the amount of $2,500,000 to take up outstanding warrants to the extent of $1,500,000 and to cover the cost of improvements to the irrigation system, carrying water from the Colorado River, was carried by a vote of nearly 3 to 1. The improvements contemplated include the installation of six waste-gates in the various canals, which will result in a saving of $100,000 a year and insure more satisfactory delivery of water during the summer.

It is also proposed to improve the dredge "Delta," install two dragline dredges, and purchase locomotives, dump cars and steam shovels, as well as to raise and strengthen levees. Further information can be obtained by addressing the County Clerk, El Centro, Imperial County, California.

New Jersey County Engineers Demand Greater Recognition

Selection of materials for pavements and other engineering public works has so often been delegated to persons having no engineering knowledge that the County Engineers' Association of New Jersey has deemed it necessary to enter a protest. Such persons, and the property owners, when selection is determined by petitions, are considered incompetent to decide problems of this character. With a view to stopping the practice, the association passed the following resolution:

Whereas, the constantly increasing use of the highways in state, counties and municipalities demands the proper, economical and efficient development of all the highway systems by the selection of proper materials to be used in the construction and maintenance of same, and

Whereas, the selection of paving materials requires expert knowledge of the probable life of materials, when subjected to the different classes of traffic, and

Whereas, it has long been the practice for governing bodies to be influenced, in the selection of materials to be used, by petitions from owners of property abutting on the line of the improvement, and

Whereas, in such selection of materials the advice, opinion and knowledge of experienced engineers has been many times rejected, resulting in the improper selection of paving materials;

Therefore, be it resolved, that the County Engineers' Association of the State of New Jersey does hereby strongly protest against, and condemn, the continuation of this practice, as being against the best interests of the public because it is promotive of excessive cost and because it is contrary to proper engineering practice

A. H. Nelson is secretary of the association.

Merchant Fleet Now Exceeds Eight Million Gross Tons

According to information from the Bureau of Foreign and Domestic Commerce, the seagoing fleet of American merchant ships of over 1000 gross tons each was on Sept. 1 composed of 3245 ships of 8,100,008 gross tons. This number has been registered for foreign trade or enrolled for coastwise shipping. One thousand five hundred and fifty-eight steamers are steel, and they represent 6,707,820 gross tons, and 347 ships are wooden, aggregating 840,611 gross tons.

More than 4,000,000 gross tons was the output of American shipyards during the twelve-month period which ended Aug. 31, 1919. With previously constructed vessels, this brings the total of tonnage built in American shipyards since Jan. 1, 1917, to 6,636,221 gross tons. This figure includes steel, wood and concrete ships, both seagoing and not seagoing. The output during August, 1919, was equivalent to 90% of the production of all American shipyards for the first six months in 1917.

Urge Coördination of Government Mapmaking Agencies

At the suggestion of the President, representatives of the Government agencies interested in mapmaking met Sept. 15, under the chairmanship of Maj. Gen. W. M. Black, Chief of Engineers, U. S. A., to discuss the situation with regard to the official map of the United States. A resolution was adopted declaring that a program of larger expenditure is imperative and that the coördination of existing mapmaking activities is a necessary step if the public funds are to be used economically.

General Black was authorized to invite to a future meeting representatives from Engineering Council, the American Association of State Geologists, American Association of State Highway Officials, National Research Council, Geological Society of America, Association of American Geographers, American Geographic Society and National Geographic Society. The representatives of those organizations will be asked to present to the Government representatives the various needs of map users.

The following Government agencies were represented at the meeting Sept. 15: The Engineer Corps of the Army; Coast and Geodetic Survey; United States Geological Survey; General Land Office; Postoffice Department; Bureau of Soils; Reclamation Service; Bureau of Roads; Forest Service; Indian Office; Mississippi River Commission; Naval Hydrographic Office; Survey of Great Lakes and Boundary Commission.

The President's action had been taken at the request of Engineering Council. The Secretary of War was directed to arrange the meeting and he, in turn, placed the matter in the hand of General Black.

In order to work out promptly the several matters involved in mapmaking, subcommittees, with chairmen, have been appointed by the main committee representing all Government agencies interested in the subject, as follows: Subcommittee on control, William Bowie, Coast and Geodetic Survey; chairman, subcommittee on base maps, Claude H. Birdseye, United States Geological Survey; subcommittee on map methods, Col. E. J. Marks, War Department; subcommittee on coördination in mapmaking, Col. C. McD. Townsend, Mississippi River Commission; subcommittee on hydrographic surveys, Capt. E. S. Parker, Navy Department. It is the intention of the subcommittees to draft plans which can be made the basis of discussion when representatives of outside organizations interested in mapmaking are called in.

Civil Service Examinations

New York State. Assistant civil engineer, State Highway Department, $1980 to $2160 per year, Oct. 25. Open to nonresidents. Apply to State Civil Service Commission at Albany before Oct. 13.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Assistant examiner, Patent Office, Washington, D. C., $1500 to $1740 per year, Nov. 19 to 21. File applications in time to arrange for examination at place selected by applicant.

Senior highway engineer, Bureau of Public Roads, Department of Agriculture, $2220 to $4000 per year, Oct. 21, File applications before Oct. 21.

Engineer, $3000 per year; assistant engineer, $1800 to $2880 per year; junior engineer, $1200 to $1740 per year; engineering draftsman, $1200 to $3000 per year, Reclamation Service. Apply until further notice.

ENGINEERING SOCIETIES

Calendar

Annual Meeting

NEW ENGLAND WATER WORKS ASSOCIATION; Tremont Temple, Boston, Sept. 30, Oct. 1-3, Albany, N. Y.

NATIONAL SAFETY COUNCIL, 168 Michigan Ave., Chicago; Oct. 1-4, Cleveland.

AMERICAN SOCIETY OF NAVAL ENGINEERS: Secretary, Lieut. Com. F. W. Sterling, U.S.N., Navy Department, Washington, D. C.; Oct. 7, Washington.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, 319 N. Waller Ave., Chicago, Ill.; Oct. 21-23, Cleveland, Ohio.

AMERICAN PUBLIC HEALTH ASSOCIATION: 169 Massachusetts Ave., Boston; Oct. 27-30, New Orleans.

CITY MANAGERS' ASSOCIATION, 1812 Tribune Bldg., New York City; Oct. 27-29, Indianapolis.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS; 304 E. Walnut St., Bloomington, Ill.; Nov. 11-14, New Orleans.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS; 29 W. 39th St., New York City; Nov. 13, New York City.

The Philadelphia Association of Members of the American Society of Civil Engineers will hold its annual meeting Oct. 6. The meeting will be devoted to a discussion of the best method of securing increased compensation for engineers.

The Twin City Chapter of the American Association of Engineers at a recent meeting indorsed, through resolutions, the bill providing for a Federal Department of Public Works, and the Townsend Federal highway bill, and rejected the Plumb plan for the nationalization of railroads. Resolutions were also adopted to petition the national board of directors to admit into the association architects and architectural draftsmen.

The Philadelphia Chapter of the American Association of Engineers has resumed its monthly meetings, and at its next meeting, Oct. 8, will discuss compensation schedules and classifications for municipal technical engineers.

The General Committee of Technical Societies of Chicago arranged a meeting held recently for the discussion of the zone system as applied to Chicago. Robert H. Whitten, director of the City Plan Commission of Cleveland, was the principal speaker.

The Southern California Association of Members of the American Society of Civil Engineers, through resolutions recently adopted, is to urge upon the Congressional representatives of the members support for the bill now pending providing for the creation of a Federal Department of Public Works. The association is to circularize its membership to secure financial assistance for campaigning for the bill.

The Oregon Chapter of the American Association of Engineers has elected the following: President, W. H. Marsh; first vice-president, O. Laurgaard; second vice-president, B. C. Ball; third vice-president, E. G. Hopson; secretary, R. W. Barnes; treasurer, W. C. Ruegnitz.

The Iowa Section of the American Water Works Association will hold its annual meeting Oct. 22-23 at Mason City. Jack J. Hinman is secretary.

The West Virginia Engineers' Association at a recent meeting adopted a resolution favoring the passage of Senate Bill No. 2232, which provides for the establishment of a Federal Department of Public Works. The association includes civil, mining, mechanical, telephone, sanitary and electrical engineers. A series of meetings has been planned to stimulate interest in public affairs, particularly those germane to the engineering profession; to encourage social relations, and to develop ethical and economic standards in the profession. A club house, centrally located in Charleston, has been obtained.

PERSONAL NOTES

PROF. JAMES M. BARKER has resigned from the civil-engineering department of the Massachusetts Institute of Technology to enter the employ of the First National Corporation, a subsidiary of the First National Bank of Boston.

O. P. MOHR, recently connected with the construction of the New Orleans Army supply base has become manager of the engineering department of the United Adjustment Bureau, Inc., New Orleans, La.

G. E. SHACKLEFORD, for a number of years chief engineer of the Republic Iron & Steel Co., Youngstown, Ohio, has been appointed consulting engineer. STANLEY H. MCKEE, assistant chief engineer, has been appointed chief engineer.

PAUL MERCIER, formerly chief engineer of the City of Montreal, Can., and later consulting engineer, has joined the staff of the Ecole Polytechnique, which is the engineering department of Laval University in Montreal. He assumed his new position Oct. 1.

A. C. GIESECKE, formerly of the Pacific Power & Light Co., Portland, Ore., is now associated with the Phoenix Utility Co., Astoria, Ore.

MAJ. WILLIAM P. ROTHROCK, U. S. A., has been discharged from the service and will take an extended vacation before entering the civil practice of engineering. During his two years in the Army Major Rothrock was in charge of the construction of Camp Logan, Houston, Tex., and he also built two helium plants at Fort Worth, Tex., another at Petrolia, Tex., and two picric-acid plants at Brunswick, Ga., and Grand Rapids, Mich.

W. H. SCALES, former chief designing engineer in Buffalo, N. Y., for the Lackawanna Bridge Co., has resigned and has become associated with W. E. Russ, architect, of Indianapolis, Ind., as chief of engineering and construction.

H. F. MERKER, for the past 11 years with the East St. Louis & Suburban Railway Co. in various engineering capacities, has resigned, and is now associated with the St. Louis Coke & Chemical Co. as chief engineer on its new plant now under construction at Granite City, Ill.

GEORGE MATTIS, for more than seven years in the engineering department of the California State Highway Commission, has resigned and has become assistant engineer on the California Railroad Commission.

MAJ. GEORGE A. MCCOLLOUGH, U. S. A., recently discharged from the service and appointed district engineer of the 8th district, Iowa State Highway Commission, has resigned to take an active interest in the Humboldt Sand & Gravel Co. CAPT. J. S. REYNOLDS, U. S. A., discharged from the service in July, has been appointed district engineer of the eighth district.

LIEUT. RAYMOND E. DAVIS, Engineers, U. S. A., who, while in the service, was assistant to the department engineer, Western department, and later served as head of vocational training for disabled soldiers at Letterman General Hospital, San Francisco, has been discharged from the service and has been appointed associate professor of civil engineering, University of Nebraska. Prior to entering the army, Lieutenant Davis was associate

professor of civil engineering, University of Illinois.

W. O'D. ROCKWELL is to be the city engineer, and J. WARD MOTTE director of public works of Savannah, Ga. At a recent meeting of the city council the offices of chief engineer and assistant chief engineer were abolished, and the offices of director of public works and city engineer were created in their stead. Mr. Rockwell and Mr. Motte were assistant chief engineer and chief engineer, respectively, under the old system.

T. O. GLADNEY, formerly of Sparkville, Miss., and for the past 16 years consulting engineer for the Atlantic Coast Line, has been appointed professor of civil engineering, Agricultural and Mechanical College of Mississippi. C. P. STOCKER, whose place Professor Gladney assumes, has become professor of civil engineering, University of Arkansas.

J. K. ANDERSON, chief engineer of the West Virginia Public Service Commission, has resigned and has opened consulting offices in Charleston. GEORGE E. TAYLOR, for the past five years assistant engineer, is now chief engineer, and WILLIAM GALLAGHER, of Charleston, has been appointed assistant engineer. Mr. Anderson will specialize in the valuation of, and rate making for, public utilities.

JACOB F. KRAKAUER, formerly appraisal engineer with the division of supply and sales of the Emergency Fleet Corporation, has joined the editorial staff of the "Iron Age Catalog of American Exports."

KARL F. UHDEN, who built the $10,000,000 dam and power plant at Long Lake, near Spokane, has accepted the engineering superintendency of the Skagit Power Development Company.

F. CLAY BAKER, construction engineer for the East St. Louis & Suburban Railway Co. for the past three years, has been appointed maintenance-of-way engineer.

L. D. BLAUVELT, consulting engineer, Denver, Colo., who, as major in the Construction Division, U. S. A., planned and built a $40,000,000 toxic gas plant at the Edgewater Arsenal in Maryland, has been appointed consulting engineer to the Colorado State Railroad Commission. The commission has been designated by the state legislature to suggest ways and means for making the Moffat tunnel under James Peak a reality. Mr. Blauvelt was previously connected with the Denver & Salt Lake Railroad.

WHITNEY C. HUNTINGTON, assistant professor of civil engineering, University of Colorado, has been made full professor in charge of the department, succeeding MILO S. KETCHUM, now head of the College of Civil Engineering, University of Pennsylvania.

HERBERT S. EVANS, professor of electrical engineering, University of Colorado, has been appointed dean of the College of Engineering, succeeding Dean MILO S. KETCHUM. Professor Evans was acting dean in the absence of Dean Ketchum during the last school year. He is president of the Colorado Section of the American Institute of Electrical Engineers, and is also an alderman and vice-mayor of Boulder.

R. F. GIFFIN has been made engineer in charge of street and sewer plans for Providence, Ky. Mr. Giffin is employed by N. E. STONE & Co., engineers and contractors, Madisonville, Ky.

MAJ. R. W. HEBARD, Engineers, U. S. A., who was with the 22nd Regiment of Engineers in France, has been discharged from the service and has resumed his position as head of R. W. HEBARD & Co., INC., engineers and contractors, 50 Broad St., New York City. The 22nd Engineers served with both the First and Second American Armies on the Meuse-Argonne and Toul-Metz fronts.

CHARLES H. WICKHAM, of Trenton, N. J., in the employ of the American Steel & Wire Co., was stricken with tropical fever in Guatemala, where he was sent to inspect an inclined haulage plane constructed at the Trenton plant, and is in a serious condition at the Belvidere Hospital, New Orleans, La.

BRUCE ALDRICH has been appointed district engineer for Canada for the Asphalt Association of New York. His headquarters will be in Toronto.

PROF. J. C. MCLENNAN, of Toronto University, who during the war was scientific adviser to the British Admiralty in connection with marine-engineering problems, has sailed from England to resume the chair of physics at Toronto.

HENRY A. PULLIAM, Paducah, Ky., has recently returned from Spanish Honduras, Central America, where American civil engineers are at work on several important projects. He was employed on engineering projects under construction by the Cuyamel Fruit Co., of New Orleans, La., such engineering work including improvement of port facilities, swamp-filling projects, railroad construction, drainage and river diversion, water-supply and hydro-electric construction. The work is being done under the direction of P. H. MYERS, chief engineer of the company.

ERNEST E. REESE, New York, has been nominated by the President as hydrographic and geodetic engineer of the Coast and Geodetic Survey. The nomination has been sent to the Senate for confirmation.

DR. FORD ASHMAN CARPENTER, for the past 28 years with the United States Weather Bureau, has been made manager of the recently established department of meteorology and aëronautics of the Los Angeles Chamber of Commerce. He has also opened offices in Los Angeles in connection with his work with the Chamber of Commerce as consulting meteorologist in climatic investigations for intensive agricultural development, water resources, and kindred matters.

CAPT. JOHN J. VANDEMOER, Engineers, U. S. A., who recently returned from France, where he served as commanding officer of the 467th Engineers, Ponton Train, has been appointed city engineer of Grand Junction, Colo., county engineer for Mesa County, and field engineer for the State Highway Commission of Colorado. Before entering the service Captain Vandemoer was assistant engineer for the United States Reclamation Service.

OBITUARY

J. W. JAYCOX, consulting engineer, Denver, Colo., died Sept. 8. From 1905 to 1909 he was state engineer of Colorado and at one time was mayor of Leadville, Colo., having previously held the offices of city engineer and councilman. He was born in Poughkeepsie, N. Y., and was a graduate of Cornell University. About 1872 he was a member of the Hayden geological expedition into the Northwest, making the trip through territory now comprising Colorado, Utah, Wyoming and the Yellowstone National Park. In recognition of his services one of the lakes in the park was named for him. Since 1882 he was a member of the American Society of Civil Engineers.

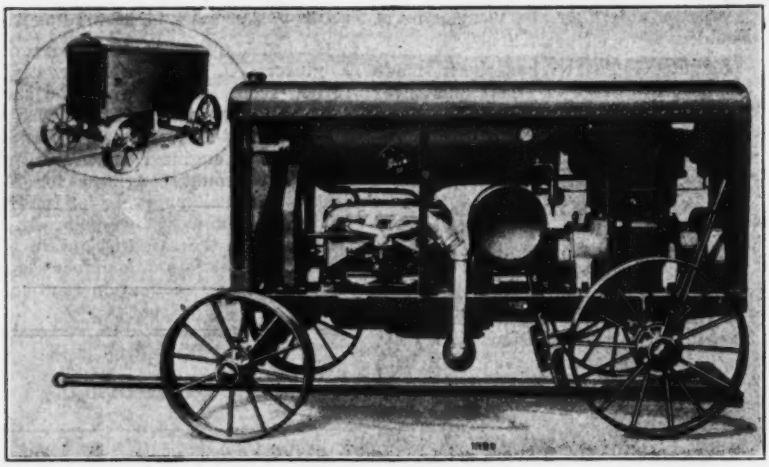
Conversant with practically every dam and hydraulic problem in the eastern Rocky Mountain region, Mr. Jaycox's office was a delight to the young engineer who was fortunate enough to have access to it.

Mr. Jaycox thought much of technical magazines and exhibited with delight complete sets of bound volumes of both *Engineering News* and *Engineering Record*, to both of which he contributed freely, believing that experiences, whatever the results, should be set down for the benefit of the profession. His interest was as great, or even greater, in telling of the failure of a detail as in its success. The tearing out of the steel lining of the outlets of the Santa Maria Lake dam was described (see *Engineering News-Record* of Jan. 24, 1918, p. 172) as freely as the new type of trip dam and sand eliminator used on the Huerfano River dam. (See *Engineering News-Record* of Apr. 24, 1919, p. 818.)

THOMAS RODEN, for 28 years superintendent of the Arlington, Mass., water-works, died recently at his home in Arlington, at the age of 74. Mr. Roden came to this country from Ireland 46 years ago.

Gas-Driven Portable Compressor Appears on Market

The Ingersoll-Rand Co. recently introduced a light-weight gasoline-driven portable air compressor, built in two sizes. All unnecessary weight has been eliminated, thereby affording maximum air-power output per unit of weight. From canopy to broad-tired wheels, these compressors are all steel.



ALL-STEEL, GAS-DRIVEN AIR COMPRESSOR OF 210 CUBIC FEET CAPACITY WEIGHS 6000 POUNDS

Each unit consists of a duplex, vertical compressor, driven at high speed by a four-cylinder, four-cycle tractor-type gasoline motor. The larger machines, of 210-cu.ft. capacity, weigh only 6000 pounds, and the 118-cu.ft. unit weighs 4000 pounds.

The compressors have cylinders cast *en bloc*, with cylinder heads, valve chambers, and water jackets integral. Both intake and discharge valves are of plate type and are located directly over the cylinder bore. Crankshafts and connecting rods are drop-forgings. Air pistons are fitted with three-piece piston rings, and, in addition, with an oil wiper ring. This latter returns all surplus oil from the cylinder walls to the crank case, and, it is said, obviates the difficulty caused by having the air carry an excess of oil into the receiver.

Both compressor and driving motor are water-cooled by a circulating system, with centrifugal pump, large radiator, and blast fan. Each compressor unit is equipped complete with receiver, safety valve, drain valves, pressure gage, and service valves to which the air-hose lines may be attached. When the fuel tank has been filled, lubricating oil provided, and the cooling system supplied with water, the units are ready for work. A swiveled front axle which moves freely in both horizontal and vertical planes, with a rigid rear axle, gives to the mounting of the machine three-point suspension.

New Plant for Chain Belt Company

With the announcement of the increase in capital stock of the Chain Belt Co., Milwaukee, Wis., from $1,000,000 to $2,800,000, comes the information that the company is planning an extensive building program, which, when completed, will give to Milwaukee one of its largest industrial institutions. The plans contemplate the ultimate evacuation of the present plant at 16th and Park Sts. and its removal to a 23-acre site at 39th and Orchard Sts. Within a few days ground will be broken for the first unit, a steel and brick structure 316 ft. x 150 ft., where the concrete-mixer assembling department will be housed. Building operations will progress by departmental units as rapidly as business conditions, removal difficulties and other considerations will permit. Plans and construction work will be under the direction of Frank D. Chase, Inc., Chicago.

TRADE PUBLICATIONS

THE INTERNATIONAL MOTOR CO., W. 64th St. and West End Ave., New York City; catalog, 4¼ x 7¼ in., 75 pages, illustrated; an exposition of the outstanding features of the Mack truck, with reasons for the adoption of such features.

THE ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, Wis.; two bulletins, Nos. 1537 and 1632 C, 8 x 10½ in. each, 30 and 50 pages, respectively; illustrated; Bulletin No. 1537 is a series of photographic plates showing the details of the Allis-Chalmers oil engine, Diesel type, to facilitate the ordering of repair and spare parts; Bulletin No. 1632 C covers centrifugal pumps and pumping units and contains tables indicating the size, revolutions per minute, horsepower, etc., of pumps when the head in feet, and the capacity in gallons per minute are known.

BUSINESS NOTES

THE S. T. ENGINEERING CORPORATION, Buffalo, recently incorporated, has elected the following officers: President, Ralph McCarty; vice-president, Henry J. Turner; treasurer, William B. Powell; secretary and general manager, Harvey H. Hickman. The new company will manufacture and sell mechanical equipment.

C. P. DAVIDSON, formerly with the Raymond Concrete Pile Co., and W. H. DAVIDSON, formerly with Stone & Webster, both of whom have recently been discharged from the Army, have organized the SOUTHERN ENGINEERING CO., manufacturers' agents, New Orleans.

JAMES POSEY and STOCKETT M. WHITELEY, consulting and operating engineers, respectively, have formed an association under the firm name of POSEY & WHITELEY, ENGINEERS, INC., and have established offices in the Fidelity Building, Baltimore, Md. The new corporation will specialize in industrial power-plant management. Mr. Posey will continue his consulting practice in the same building.

H. BORTIN, cost accountant and highway engineer, who maintains offices in St. Louis and New York City, has associated with him as chief engineer W. L. LOVE, former superintendent of highway construction in Harris County, Texas.

THE STANDARD CHEMICAL CO., Toronto, the stock of which is largely held in England, has selected as its new president DAVID GILMOUR, a Scottish engineer of wide experience in various enterprises in South Africa, South America and the United States. During the war he served the British Government in the design and operation of factories for the manufacture of munitions.

J. H. KENYON is president and J. SCOTT THOMPSON is secretary-treasurer of the recently organized KENYON-THOMPSON CO., general contractors, Raleigh, N. C. The new company will engage in a general contracting and building business, specializing in fire-resisting and brick structures.

THE LACLEDE STEEL CO. has moved its offices from the Federal Reserve Bank Bldg. to the Arcade Bldg., St. Louis.

THE BOWERS SOUTHERN DREDGING CO. announced that it would open offices in New York City Oct. 1, closing the Philadelphia office at 688 Bourse Building.

THE CHICAGO PNEUMATIC TOOL CO. will move its Birmingham office Oct. 1 from 801 Brown Marx Bldg., to 1925 Fifth Ave., North, where a service station with a complete stock of pneumatic tools, electric tools, air compressors, oil engines, rock drills, and repair parts will be maintained.